Saskatchewan
Parks, Recreation
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Fisheries Branch

Biological Reassessment of the Dore Lake Fishery

Technical Report 87-5

BIOLOGICAL REASSESSMENT OF THE DORE LAKE FISHERY

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Saskatchewan Fisheries Laboratory

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By

W. W. Sawchyn

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EXECUTIVE SUMMARY

Dore Lake, located 193 km northwest of Prince Albert, has experienced a serious and progressive decline in walleye stocks since the early 1960s. This report describes a detailed fisheries survey undertaken in the summer of 1986 to evaluate the issue of declining walleye populations relative to the other fish species. It proposes a fisheries management strategy which will provide improved opportunity for the recovery of walleye numbers.

Dore Lake has been commercially fished since 1911 and actively fished by sport fishermen since 1956. The fishery resource presently supports 23 active commercial fishermen, three outfitters' lodges, numerous cottage and day anglers, and one mink ranch. The commercial fishery presently relies primarily on a strong population of whitefish; northern pike provide the mainstay of the recreational fishery. Both fisheries are feeling the effects of the depleted walleye stocks.

Suckers, ciscoes and small yellow perch made up 84% by number and 64% by weight of the fish caught in test nets. Of the large species, whitefish made up 10%, pike 4%, and walleye less than 1% of the total number of fish caught.

Walleye, which showed a serious decline in numbers between 1956 and 1965, continue to decline to the point where only 51 fish were caught in 39 net sets. Most of the walleye caught were larger than 30 cm, ranged from 3 to 5 years of age, showed low recruitment and rapid growth rate. Walleye now take 3 to 5 years less time to achieve catchable size than samples taken in 1956. As a result

65% of the walleye caught, though relatively large, were still immature.

A strong population of whitefish, ranging in size from 30 to 42 cm, is present in Dore Lake. A sizeable sample of young fish indicates good reproductive success. Whitefish ranged in age from 1 to 12 years with the bulk of the harvestable population being 5 to 6 years old. Lack of significant numbers of older fish suggest recruitment failure for several years in succession prior to 1981-82, very heavy fishing pressure or a combination of both.

The majority of northern pike caught were more than 50 cm long and weighed more than 1 kg. The population is young and is growing rapidly, obviously benefitting from the abundance of perch, suckers and minnows.

The study concluded that fishing pressure and reproductive failure have created a severe imbalance in the Dore Lake fish population resulting in the virtual elimination of the walleye stocks, and a buildup of rough fish species. Rapid growth rate of remaining walleye is causing them to become vulnerable to angling and gillnetting before they are able to express their reproductive potential. Perch may be competing with walleye for food resources and may be preying on walleye fry and fingerlings. Beaver dams cleared from the Sled River probably interfered less with walleye spawning than they did with the migration of northern pike. Large populations of cormorants do not appear to be feeding extensively on gamefish species in Dore Lake.

The study recommends that the total commercial fishery quota remain unchanged at 272 100 kg per year, but that separate species quotas be instituted to protect the sport fish species. The total quota should be apportioned as follows: 4 000 kg for walleye, 20 000 kg for northern pike, and 248 100 kg for lake whitefish. Lake closure should take effect when any of the three quotas have been reached.

Walleye fishing by anglers should be restricted to a daily catch of three fish. The summer commercial fishery on Dore Lake should be closed August 15 to protect walleye concentrations in the northern part of the lake, and the late autumn whitefish spawning run in Bazill Bay. The spring closure of Bazill Bay to commercial fishermen in the period from breakup to May 31 should be extended to include anglers. No new developments should be undertaken on Dore Lake which would place added pressure on the sport and commercial fish species presently being utilized.

The current fur farm fishery should be allowed to continue so long as it harvests about 90% suckers and burbot. However, no new fur farm fishing licences should be permitted on the lake.

The restrictions on commercial fishing and angling for walleye should be reassessed in 5 years relative to changes in walleye populations.

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1. INTRODUCTION

Dore Lake has been the scene of an active commercial fishery since the turn of the century. Improvements in road access in the mid to late 1950s opened the lake to the development of a sport fishery based on the large walleye population then present in Dore Lake. A rapid expansion of fur farming during the early 1950s provided yet a third source of high demand on the fishery resources of Dore Lake.

In light of this heavy fishing pressure, a biological survey was undertaken in 1956 (Ruggles 1959a) to assess the lake as a fish habitat and to describe the composition and structure of its fish resources. The survey described Dore Lake as characteristically a cisco-walleye lake. Whitefish were abundant and fast growing. Perch were an important forage species for both pike and walleye. The study noted that the commercial harvest in Dore Lake averaged about 5.6 kg /ha. Combined with the fish harvested as mink food, the annual harvest from the lake was approximately 13.4 kg /ha. The study predicted a rapid expansion of the walleye fishery as the tourist industry became established. It recommended that a further study of the walleye population be made after the tourist industry became more developed.

In the early 1960s a drastic change in the fish populations in Dore Lake appeared to take place (Johnson 1968). Sport fishermen complained about the small size and poor catches of walleye and pike. Large walleye were becoming scarce in the commercial catches and burbot catches increased dramatically in the winter catches. "By 1964 collapse of the commercial fishery seemed imminent, as whitefish in that year were difficult to catch." (Johnson 1968). A second survey of the lake was undertaken in the summer of 1965 to identify possible ecological

changes in the lake responsible for the observed decline in fish resources. The average catch of fish in standard gang survey nets increased in numbers but dropped in weight largely due to greater numbers of small ciscoes and perch and fewer and smaller walleye and pike. The whitefish population appeared relatively stable. The study concluded that decreases in numbers and size of walleye and pike were a result of natural factors affecting the reproduction of these species for at least 4 successive years. Indications in 1967 were that angling was improving, and the sport fishery would recover shortly.

Present indications are that the walleye fishery never did recover but continued to decline to the point where it is virtually nonexistent.

Whitefish populations improved during the 1970s but took a turn for the worse in 1979. Doug Walton who investigated the problem in 1982 (Walton 1983) concluded that a whitefish parasite, the spiny-headed worm, *Echinorhynchus salmonis*, was primarily responsible. To compound the problem, commercial fishermen faced with a shortage of lake whitefish in deep water, turned to the shallow water in search of the species. As a consequence, large numbers of pike were taken resulting in complaints from the outfitters who had come to rely on the latter following the collapse of the walleye fishery.

The present study is in response to appeals from the commercial fishermen, the outfitters and sport fishermen to identify the problems with the fisheries resource in Dore Lake and to recommend corrective management strategies.

2. THE STUDY AREA

Dore Lake is situated in west-central Saskatchewan (54°46' Lat., 107°17' Long.) 193 km northwest of Prince Albert and 96 km northeast of Meadow Lake (Fig. 1). It is accessible by Highways 55 and 124. The lake lies on glacial deposits south of the Precambrian Shield (Ruggles 1959a) at an elevation of 459.0 m A.S.L. Dore Lake is part of the upper Churchill River drainage. For practical purposes it is considered as a headwater lake emptying into Lac Ile-a-la-Crosse and the Churchill River by way of the Dore and Beaver Rivers. The total drainage basins is estimated at 2435 km^2 encompassing the sub-drainage basins of Mirasty, Beaupre and Sled Lakes (Johnson 1968). The latter drain into Dore Lake by way of the Sled River. Because of the proximity of the inflowing Sled River and the Dore River outlet it is unlikely that the Sled River drainage has any significant influence on the physical and chemical characteristics of Dore Lake outside of Bazill Bay. All other drainages into the lake are minor and intermittent.

With a surface area of 615.8 km^2 (238 mi^2) Dore Lake is among the largest of the lakes in Saskatchewan which are situated entirely on glacial deposits. It is roughly circular with the main body of water open and exposed to prevailing northwest and southeast winds. The lake has 26 islands, most of which are located in a chain extending from the northeast margin of the lake. As a result these provide little protection from storm conditions.

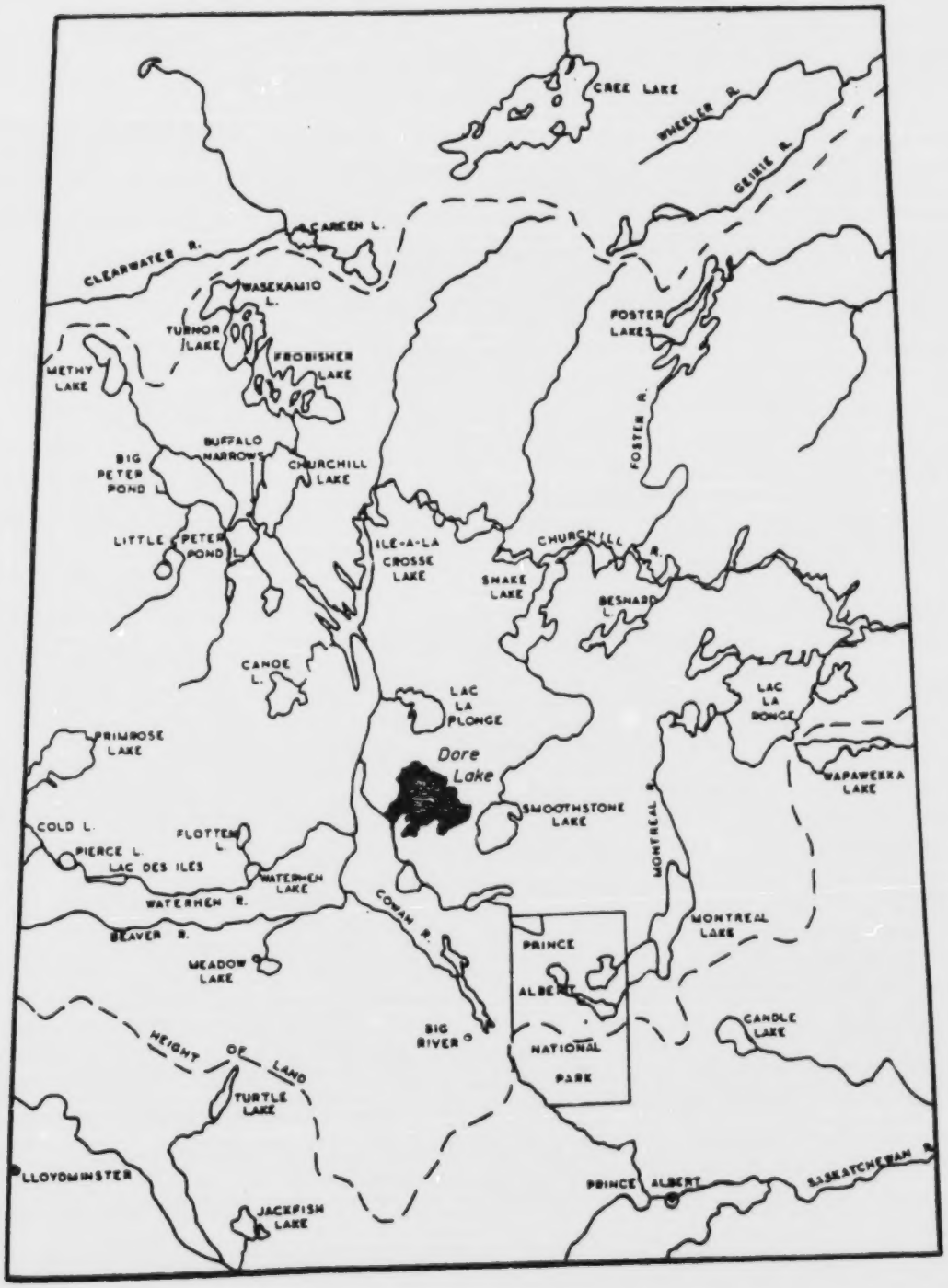


Fig. 1 Map showing the location of Dore Lake.

Bottom contours of the Dore Lake basin were charted by echo sounder in each of the two earlier studies (Ruggles 1959a; Johnson 1968). A bathymetric map prepared in the latter study is provided for reference (Fig. 2).

3. THE 1986 FIELD PROGRAM - MATERIALS AND METHODS

The present study was designed after the 1965 survey to provide a basis for direct comparison of results between the two studies. Field investigations began on May 29, 1986 and were completed on August 27 of the same year. With the exception of the latter part of June, the study alternated between 10 days of field investigation and 4 days at the laboratory.

Field measurements of physico-chemical conditions were made at approximately two week intervals beginning on May 31. One site was selected for these measurements. This was located midway between Michel Point and Spruce Point approximating the location of limnological Station B of Johnson's (1968) study. Limnological measurements included water temperature and dissolved oxygen profiles using a YSI temperature - dissolved oxygen meter; pH measurements of surface and bottom water samples carried out colorimetrically with a Hellige pocket comparator; and Secchi disc transparency measured with a white 20 cm diameter Secchi disc. In addition total vertical hauls of net plankton were taken for measurement of total plankton biomass. These samples were obtained with a 25 cm diameter Wisconsin plankton net made of No. 20 bolting silk (80 μ pore size). Net efficiency was established by straining known quantities of water through the net.

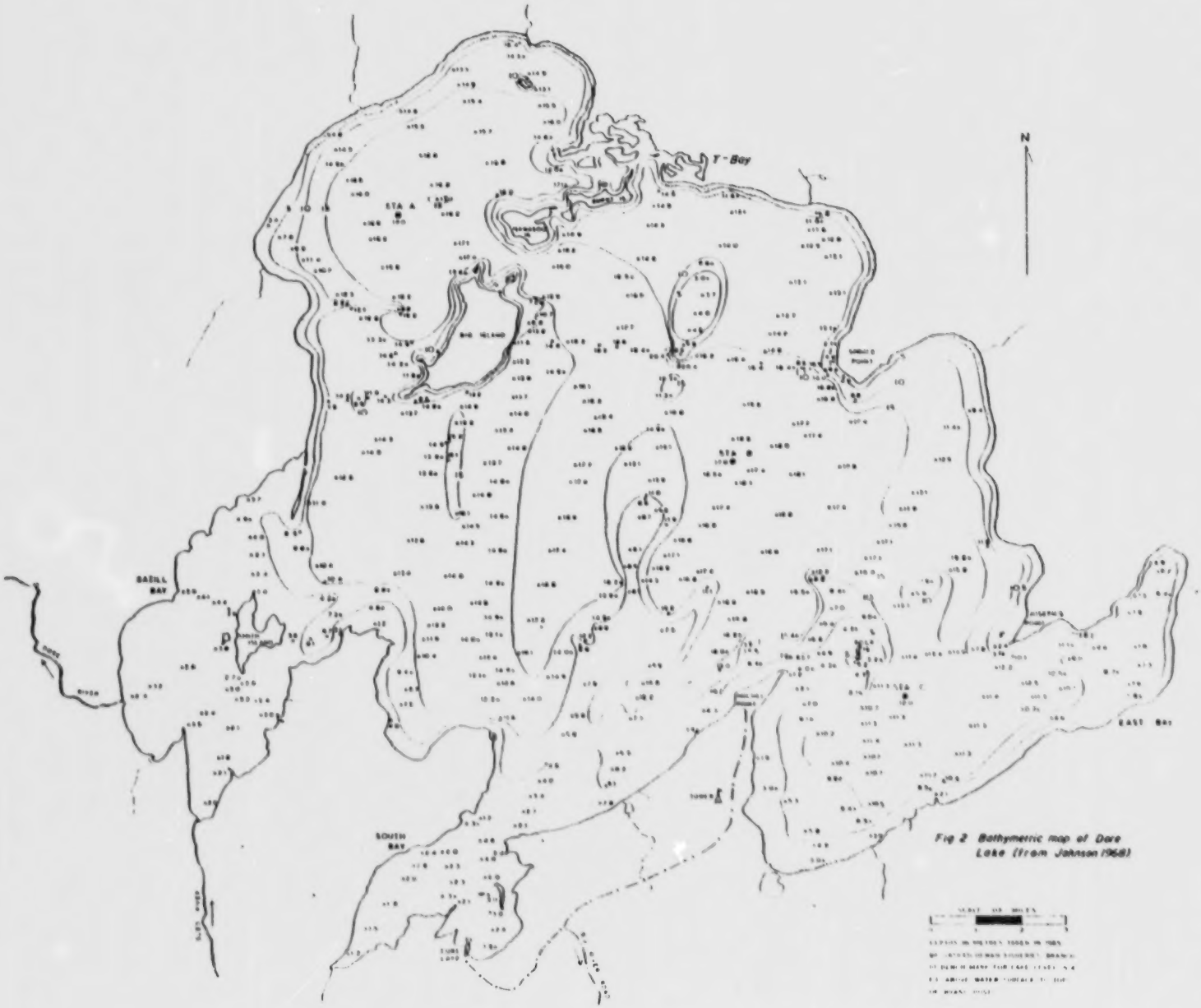


Fig 2 Bathymetric map of Dore Lake (from Johnson 1968)

Two litre surface and bottom samples were collected with a Kemmerer water sampler for chlorophyll analysis. The samples were filtered under vacuum immediately after sampling, using Gelman Type A-E glass fiber filters and a hand-operated vacuum apparatus. The filters were then put into manilla coin envelopes and refrigerated until extraction was carried out in the laboratory. Chlorophyll was extracted using acetone and measured spectrophotometrically following the method of Lorenzen (1967). Levels of chlorophyll a and phaeopigments were determined.

A composite water sample was prepared from surface and bottom subsamples and submitted to the Provincial Laboratory for an analysis of basic chemical parameters.

Lake benthic fauna were sampled with a 500 cm^2 Ekman dredge. Eleven series of 6 samples were taken. The samples were washed through a graded series of 3 screens, the finest with 11 meshes/cm. Organisms were recovered from the screens and preserved in 70% alcohol. Identification, enumeration and weights were determined in the laboratory.

Fish fauna were evaluated using 276 m long standard gangs of gill nets consisting of 46 m lengths of 3.8-, 5.1-, 7.6-, 10.2-, 12.7- and 14.0 cm meshes linked in series. Thirty-nine net sets were placed in Dore Lake during the summer, in locations roughly comparable to those made in the 1965 study. Minnows, fingerlings and fry were collected by beach seining and fry traps. Estimates of angler catches were made from fish remains examined at fish filletting tables located at the two fishing lodges and at public camp sites.

Analyses of fish obtained by gillnetting included numbers, lengths and weights of sport and commercial fish species caught in each mesh size. Rough fish species such as suckers, ciscoes, perch and burbot were enumerated, maximum and minimum lengths and total weights by species were recorded. Data on sex, state of maturity and diets were recorded for the sport and commercial fish species. Scales, otoliths, fins and cleithra were collected from fish of economic importance for age determination.

Beach seining and minnow traps were used to collect samples of small fish which were identified and enumerated. These provide a measure of food available to the larger piscivores. Fish remains obtained from the filletting stations were identified, measured and sexed to provide information on the segment of the fish population being harvested by anglers.

4. RESULTS

4.1 MORPHOMETRY AND PHYSICO-CHEMICAL FEATURES

4.1.1 Depth and Lake Level

The morphometry of Dore Lake has been thoroughly investigated in the two previous studies (Ruggles 1959a; Johnson 1968). Dore Lake is generally shallow with a maximum depth of about 20 m. Nearly two-thirds of the lake overlies depths shallower than 10 m (see Fig. 2, from Johnson 1968). Other morphometric characteristics are provided in Table 1 (adapted from Johnson 1968).

Table 1. Summary of morphometric characteristics of Dore Lake.

Depth Zone, m (ft)	Water Area, km^2	% of Lake Area in Depth Zone	% of Lake Volume in Depth Strata
0-5 (0-16)	136.8	22.2	40.9
5-10 (16-33)	96.8	15.7	32.2
10-15 (33-49)	213.3	34.6	20.6
15-20 (49-66)	168.7	27.4	6.3
20-20.4 (66-67)	0.2	0.1	+
Total	615.8	100.0	100.0

Maximum depth - 20.4 m (67 ft)

Mean depth - 10.9 m (35.8 ft)

Water volume - 66.897 X $10^8 m^3$
5 423 586 acre-feet

Islands: number - 26
area, km^2 - 12.2

Shore length of lake - 195.0 km

Shore length of islands - 52.8 km

Shore development: excluding islands - 2.2
including islands - 2.8

Measurements of lake level taken on June 1, 1986 relative to the bench mark installed in the 1965 survey showed water levels to be down 9.7 cm from the previous study.

4.1.2 Temperature

Physico-chemical measurements were begun on May 31, two days after the last of the ice had disappeared from Dore Lake. Temperature profiles obtained from Station B in the main part of the lake were compared with measurements taken in 1956 and 1965 (Fig. 3). The data show a rapid increase in surface temperature from 3°C on May 31 to 10°C on June 14 in 1986. The sudden increase in temperature created a thermocline at the 12 m level. In 1986 and in the two previous studies evidence of thermal stratification was short lived leading to the conclusion that the lake is too shallow to provide for a stable hypolimnetic zone. Maximum summer temperatures ranged from 19-20.5°C, generally being sustained in this range in the first two weeks of August. Temperatures begin to drop after mid August. The lake would normally remain ice free until about the last week of October

4.1.3 Dissolved Oxygen

Measurements of dissolved oxygen were taken concurrently with temperature profiles. Dissolved oxygen profiles plotted in Fig. 4 show a seasonal decline in oxygen levels. Some of this decline is associated with the reduced carrying capacity of warmer water, since, with the exception of the bottom stratum, a substantial decline in dissolved oxygen levels is not reflected in a lowered percent saturation

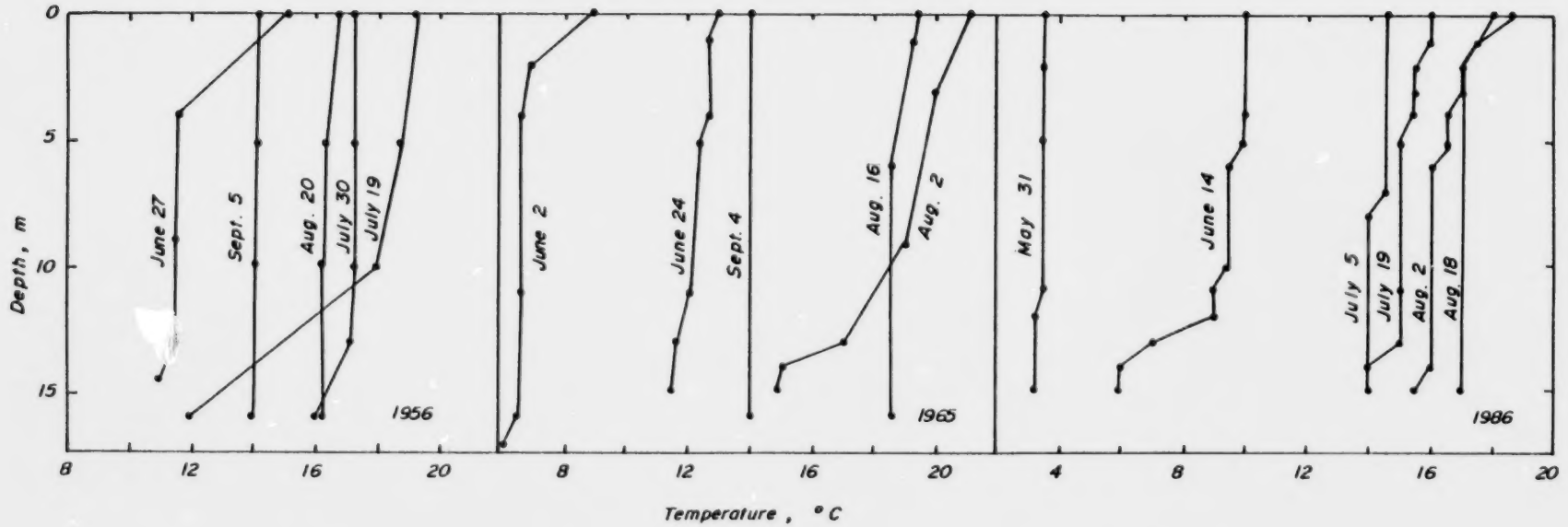


Fig. 3 Comparison of temperature profiles in the main part of Dore Lake (Station B) in 1956, 1965 and 1986.

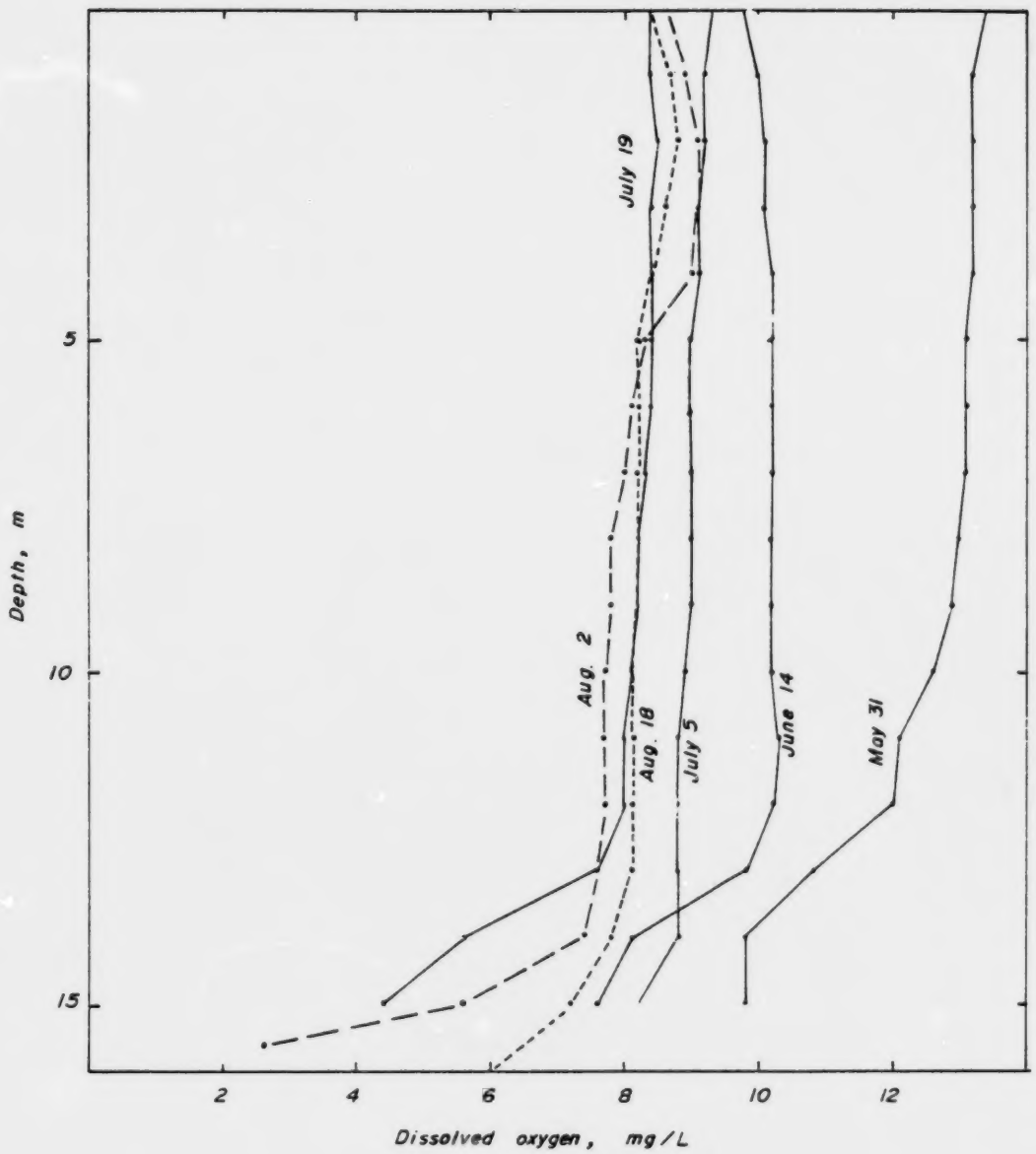


Fig. 4 Dissolved oxygen profiles, Station B, Dore Lake, 1986.

(Table 2). Dissolved oxygen levels were generally constant down to a depth of 12 m, ranging from 85% to 104% saturation. In the bottom 2.5 m, oxygen levels were below 6 mg/L on two dates, July 19 and August 2. On the latter date, the levels at the substrate-water interface may have been low enough to prevent fish from inhabiting this zone.

In 1965 Johnson noted "...that a substantial part of the bay north of Big Island is rendered uninhabitable to bottom-feeding fish for extended periods, at least in some years" because of low dissolved oxygen levels (Johnson 1968). Three measurements were made in North Bay in this study during the summer to confirm these observations. The results of the measurements (Table 3) are similar to the observations made in 1956 and 1965. Dissolved oxygen dropped sharply in the bottom two metres to levels lower than those necessary to sustain fish. The levels were substantially lower in this bay in the latter part of August than in the main part of the lake.

4.1.4 pH and Transparency

Field measurements of pH were made colorimetrically on samples of water taken from near the lake surface and lake bottom (Table 4). pH values of 8.5 and 8.7 were recorded near the lake surface and bottom, respectively, just after spring breakup. Values dropped by July and appeared to stabilize at 8.3 and 8.1.

Measurements of the transparency of the water using a light reflecting white Secchi disc were made on each of the six occasions that limnological observations were carried out. Visibility of the Secchi disc dropped from 4.0 m on May 31 to 2.2 m on August 18 (Table 4).

Table 2. Percent saturation of dissolved oxygen in Dore Lake, 1986.

Date	Surface			Mid Depth			Bottom		
	Temp. °C	DO[1]	% Sat.	Temp. °C	DO[1]	% Sat.	Temp. °C	DO[1]	% Sat.
May 31	3.0	13.4	103.9	3.0	13.1	101.6	2.5	9.8	75.4
June 14	10.0	9.8	90.7	9.5	10.2	92.7	6.0	7.6	63.9
July 5	14.5	9.3	94.9	14.5	9.0	91.8	13.5	8.2	82.0
July 19	16.0	8.4	88.4	15.0	8.3	85.6	14.0	4.4	44.4
Aug. 2	18.5	8.7	96.7	16.0	8.0	84.2	15.0	2.6	26.8
Aug. 18	18.0	8.7	95.6	17.0	8.2	88.2	16.5	6.0	63.8

1. Measured in mg/L.

Table 3. Temperature and dissolved oxygen profiles in North Bay (Station A) of Dore Lake, 1986.

Depth (m)	June 13		July 19		August 18	
	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	8.0	11.8	16.0	8.8	20.0	8.4
1	8.0	11.8	16.0	8.8	16.0	9.6
2	8.0	11.8	16.0	8.8	15.0	9.3
3	8.0	11.8	16.0	8.8	15.0	8.4
4	8.0	11.7	16.0	8.8	15.0	8.3
5	8.0	11.7	16.0	8.8	15.0	8.2
6	8.0	11.7	16.0	8.6	15.0	8.2
7	8.0	11.7	16.0	8.6	14.8	8.1
8	8.0	11.6	16.0	8.5	14.5	8.1
9	7.8	11.8	16.0	8.5	14.5	8.1
10	7.8	11.6	16.0	8.5	14.5	8.1
11	7.8	11.6	16.0	8.4	14.5	8.1
12	7.5	11.4	16.0	8.2	14.0	8.1
13	7.0	11.0	16.0	8.2	13.5	8.1
14	6.0	9.8	16.0	8.1	13.0	0.9
15			14.0	5.4	11.0	0.1
16			13.0	3.6	10.5	

Table 4. pH measurements and Secchi disc transparency, Dore Lake, 1986.

	pH		Secchi disc Transparency (m)
	Surface	Bottom	
May 31	8.5	8.7	4.0
June 14	--	--	3.5
July 5	8.3	8.1	2.9
July 19	8.2	8.1	2.9
Aug. 2	8.3	8.1	2.4
Aug. 18	8.3	8.3	2.2

The change in transparency is a reflection of increased amounts of suspended material, primarily algae, in the water. A comparison of the present values with those obtained in 1956 and 1965 (Fig. 5) shows much lower transparencies than in 1965. Values obtained after July 15 are comparable to transparencies measured in 1956.

4.1.5 Water Quality

Water samples were collected from near the surface and bottom of Dore Lake on each date that limnological measurements were undertaken. The samples were frozen and returned to the laboratory where they were thawed and combined into one composite sample for analysis. The analyses included major ion constituents for direct comparison with results from chemical analyses undertaken in 1941 and 1965 (Table 5).

The results show a trend towards a reduction in total dissolved solids derived primarily from reductions in calcium and sodium bicarbonate levels. The low levels of salts in the sample analyzed in the present study may have been the result of salt precipitation when the samples were frozen. In view of this it is difficult to conclude whether the changes in major ions reflect a trend in long term reduction in salinity.

At a total dissolved solid concentration of 203 mg /L, Dore Lake would be considered to be mildly eutrophic contrasting with oligotrophic Shield lakes which generally have dissolved solids levels of less than 100 mg/L and the nutrient rich southern lakes with total dissolved solids in excess of 500 mg/L.

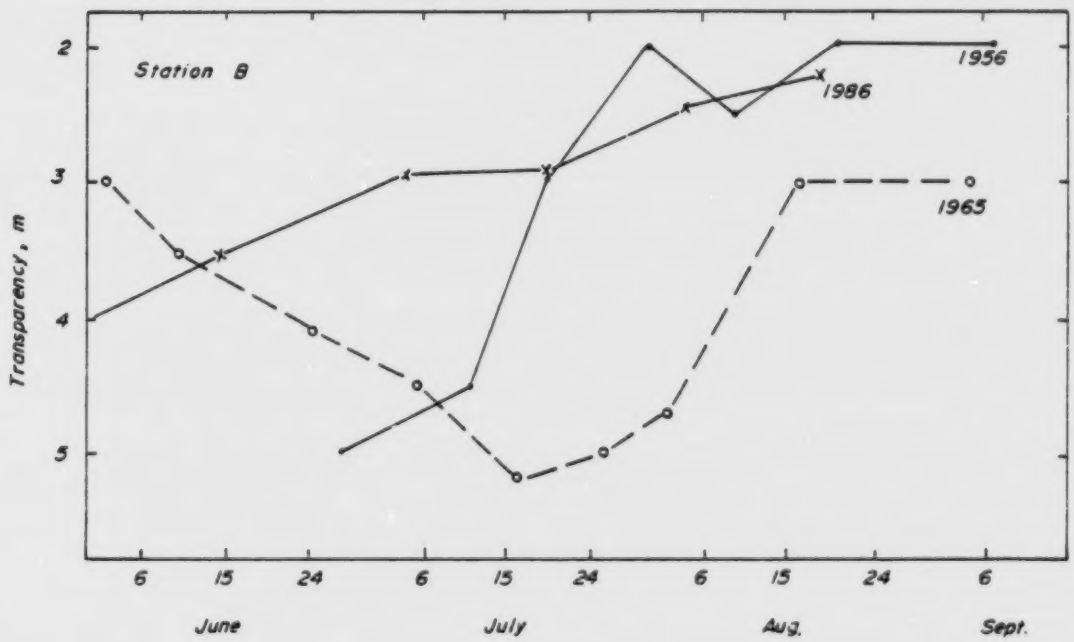


Fig. 5 Water transparency as measured by Secchi disc in Dore Lake, 1956, 1965 and 1986.

Table 5. Chemical analyses of water from Dore Lake.

Date Location	1941[1]	Feb. 10 1965[2] South Bay	June 2 1965[2] Station "B"	1986 Summer Composite Station "B"
Total dissolved solids @ 110°C	206	210	190	--
Total dissolved solids, calc.	234	278	257	203
Loss on ignition @ 550°C	--	45	40	--
Specific conductivity, µmhos/cm	--	325	300	237
Carbonate ($CO_3^=$)	0.0	0.0	0.0	--
Bicarbonate (HCO_3^-)	170	209	196	157
Chloride (Cl^-)	0.0	2.1	1.4	4
Sulphate ($SO_4^=$)	5.9	0.0	0.0	<10
Silica (SiO_2)	14.3	17.5	14.4	--
Calcium (Ca^{++})	13.6	33.0	31.2	11
Magnesium (Mg^{++})	7.9	17.2	16.3	16
Sodium (Na^+)	36.5	12.6	9.6	11
Potassium (K^+)	--	4.1	2.9	4
Nitrate (NO_3^-)	--	--	--	<1
Total alkalinity (as $CaCO_3$)	140	--	--	129
Total hardness (as $CaCO_3$)	--	--	--	92
Iron		--	--	0.2
Manganese		--	--	<0.01

1. From Ruggles 1959a

2. From Johnson 1968.

4.2 PLANKTON

The collection and analysis of plankton, the microscopic plant and animal life suspended in the water, provides a measure of the productive potential of a lake. Although the strength of this study centered on the fishery of Dore Lake, some plankton samples were obtained as an alternative method for productivity assessment and measure of change from results of earlier studies.

Plankton samples, collected at approximately one month intervals, were used for measurement of chlorophyll a and phaeopigments (chlorophyll degradation products) (Table 6).

Chlorophyll a levels in Dore Lake were lowest in the spring just after breakup. Higher and generally constant levels were reported in the months of July and August. Highest phaeopigment levels reported for both surface and bottom samples on July 5 suggest some chlorophyll breakdown in the sample, perhaps as a result of improper storage. Chlorophyll a levels in Dore lake are low by comparison with other lakes in the province. They border on the upper margin of levels determined by Liaw (1982) as being typical of lakes occurring in forested areas (3.337 ± 1.131) and are considerably lower than chlorophyll a levels found in lakes of mixed wooded-cultivated (8.015 ± 1.409) and agricultural-urban (40.674 ± 21.504) watershed categories.

Measurements of total plankton biomass were made on 6 occasions at approximately two week intervals during the 1986 field season (Table 7). Calibration of net efficiency complemented the total vertical plankton haul taken on each sampling date (with the exception of the first sample taken). The use of a new plankton net resulted in very high net efficiencies ranging from 79.5% at the beginning of the field

Table 6. Levels of chlorophyll *a* and phaeopigments (µg/L) in Dore Lake plankton, 1986.

Date	Surface		Bottom	
	Chl-*a*	Phaeo P	Chl-*a*	Phaeo P
May 31/86	1.337	1.283	--	--
July 7/86	3.341	2.642	3.675	2.813
July 19/86	2.940	0.381	2.473	1.176
August 18/86	3.742	1.497	4.010	1.835
Mean	2.840±1.054	1.451±0.932	3.386±0.808	1.941±0.824

Table 7. Standing crop of net plankton in Dore Lake, 1986.

Date	Standing Crop (kg/ha)	% Ash	% Net Efficiency
May 31	11.6	36.6	79.5*
June 14	22.9	47.2	79.5
July 5	50.8	42.5	74.0
July 19	61.4	42.5	48.9
Aug. 2	43.8	40.9	52.5
Aug. 18	57.3	31.9	43.4

* Net efficiency not measured; value obtained June 14 used to calculate standing crop.

season to 43.4% at the end of the season. These numbers contrast with the 16.4% net efficiency used by Johnson (1968) to calculate plankton standing crop in 1965.

Plankton standing crop increased from 11.6 kg/ha shortly after breakup to 61.4 kg/ha at the height of the growing season. All values are well below the mean of 86.0 kg/ha obtained by Johnson in 9 samples collected in 1965 and the mean of 76.3 kg/ha obtained in 1956 (recalculated by Johnson using 16.4% net efficiency). Ruggles (1959a) calculated an average standing crop of 59.4 kg/ha from 22 samples using a 25% net efficiency. The latter value falls in the range of observation in the present study. It would appear that the high values derived by Johnson (1968) are a result of unusually low net efficiency values used in the calculation.

The pattern of seasonal changes in plankton standing crop obtained in this study is similar to trends reported by Johnson but contrasts with midsummer low values in 1956 reported by Ruggles (1959a) (Fig. 6).

An assessment of the numbers and species diversity of plankton was not undertaken in this study. Johnson (1968) reported 5 genera of diatoms, *Asterionella*, *Fragillaria*, *Melosira*, *Synedra* and *Tabellaria*, and one species of blue-green algae, *Lyngbya* among the dominant phytoplankters. Generally, the predominance of these diatoms suggests oligotrophic conditions, whereas *Lyngbya* is more indicative of eutrophic plankton.

4.3 BOTTOM FAUNA

Lake bottom fauna are important elements in the diets of bottom feeding fish such as lake whitefish and suckers. An assessment of

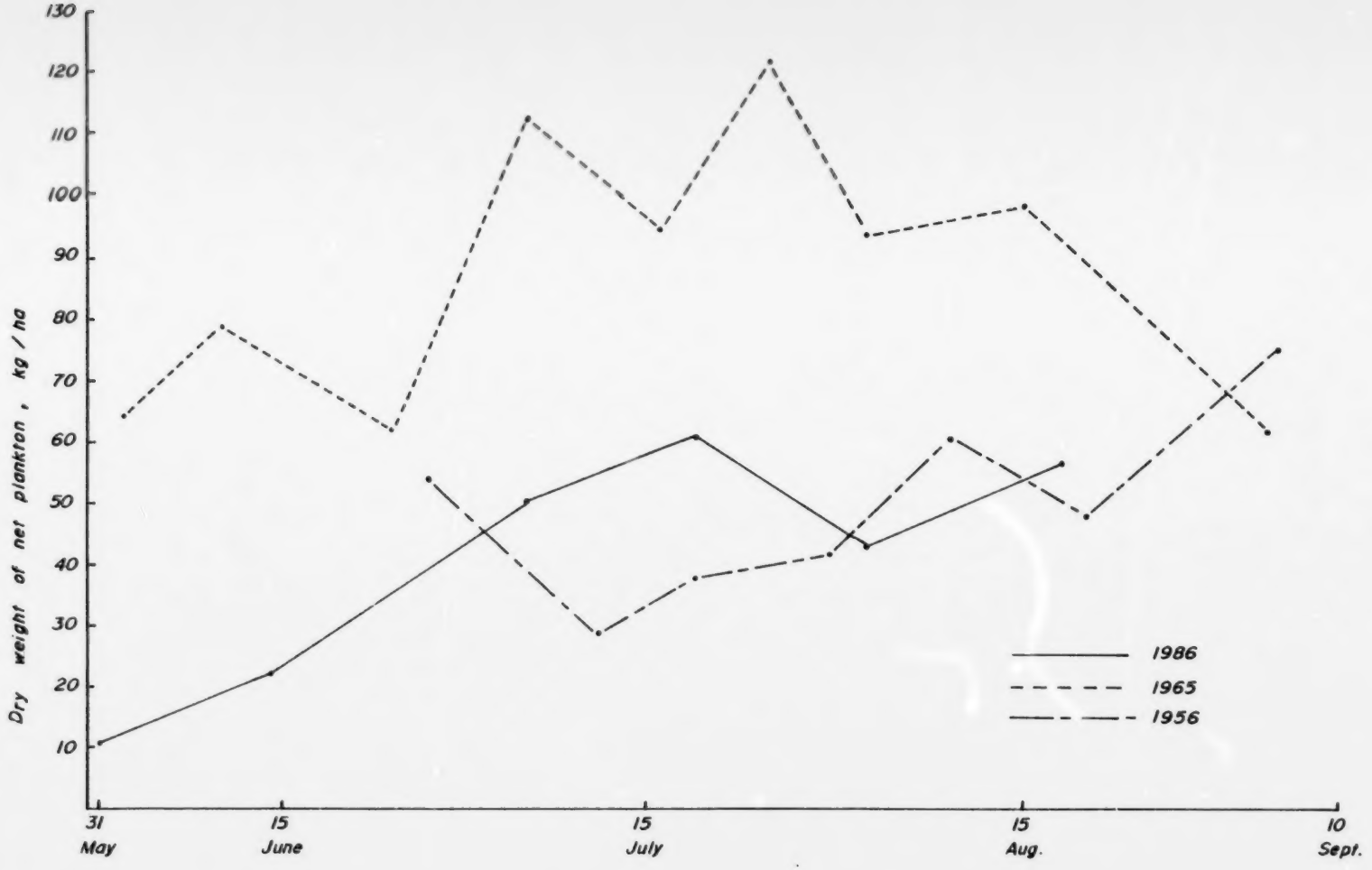


Fig. 6 Comparison of standing crop of net plankton in Dore Lake in 1956, 1965 and 1986.

numbers and diversity of bottom organisms provide a measure of the productive potential of a lake.

In the present study, 65 samples of benthic fauna were collected with an Ekman grab sampler for comparison with samples taken in 1956 and 1965. The samples were taken in 6 transects shown in Fig. 7. All samples were washed through a series of 3 screens, the finest having 11 meshes /cm providing a pore size of 0.65 mm. The invertebrates were removed from the dredge screens and preserved in 70% alcohol.

Laboratory analysis included identification of the specimens in major invertebrate categories and determination of the total weight of the samples. Mollusc shell weights, equivalent to one-third of the total mollusc weight, were deducted from the total wet weight. Total dry weight was equivalent to 12% of the wet weight in calculating standing crop of bottom fauna.

As was found in the 1956 and 1965 studies, chironomid or midge larvae, were the predominant benthic organism found in the lake sediment samples. Amphipods, sphaeriid clams and oligochaetes, or sludge worms made up less significant proportions of the total population (Table 8). Total numbers of bottom fauna were one-fifth of the numbers reported in 1965 and slightly more than one-third of the numbers found in 1956. Standing crop of bottom fauna based on wet weight of organisms collected was calculated at 22.4 kg/ha, approximately one-half of the values reported in 1956 and 1965. Large differences in numbers were reported in all invertebrate groups collected. Most severe reductions were in the numbers of sphaeriids organisms which contribute little

Fig. 7 Dredge series locations in Dore Lake, 1986.

Table 8. Comparison of bottom fauna in Dore Lake, 1956, 1965 and 1986.

Year	Average* No. of Organisms per square metre			Percent of Total		
	1956	1965	1986	1956	1965	1986
No. of samples	107	159	65			
Amphipods	196	370	72	12.2	10.7	10.5
Chironomids	1096	1837	483	68.0	53.2	70.5
Oligochaetes	71	277	56	4.4	8.0	8.2
Sphaeriids	210	854	37	13.0	24.7	5.4
Gastropods	14	37	17	0.9	1.1	2.5
Miscellaneous	24	81	20	1.5	2.3	2.9
Total Numbers	1611	3456	685	100.0	100.0	100.0
Average* wet wt (g/m^2)	33.76	42.62	18.68			
Average* dry wt (kg/ha)	40.5	51.1	22.4			

* Average for lake weighted by percent area in each depth zone.

in terms of biomass but are a significant component in the diets of lake whitefish. Even with the drastic reduction in numbers and weights of benthic fauna since the 1965 study, Dore Lake still ranks among the more productive boreal lakes such as Waskesiu (Rawson 1960), Little Peter Pond (Rawson 1960), Canoe (Ruggles 1959b) and Montreal Lake (Mendis 1956).

A comparison was made of the depth distribution of major groups of benthic fauna with those of the earlier studies (Table 9). In 1986, largest numbers of invertebrate fauna were collected in the 0-5 m zone followed closely by the 10-15 m zone. The distribution was roughly similar to that of the 1956 study. Amphipods and snails are typically most abundant in shallow water. Chironomid larvae and sphaeriids are abundant at all depths down to 15 m. Oligochaetes were most abundant and were uniformly distributed in the ooze substrates in water deeper than 5 m. Generally, the conclusions drawn about the relative abundance and depth distribution of benthos sampled in 1965 apply in this study. Populations of all species are, however, considerably lower.

4.4 FISH

4.4.1 Fish Species

Several methods were used in evaluating the fish fauna of Dore Lake. Beach seining and trapnetting provided information on distribution and relative abundance of the forage species and the immature specimens of larger fish. Standard gillnetting provided data on the larger fish of importance to the sport and commercial fisheries.

Table 9. Comparison of bottom fauna by numbers and weight per square metre in each depth zone of Dore Lake, 1956, 1965, and 1986.

Depth zone, metres	0-5			5-10			10-15			15-20		
	1956	1965	1986	1956	1965	1986	1956	1965	1986	1956	1965	1986
No. of dredgings	20	57	22	15	27	11	36	41	17	36	34	15
Amphipods	753	1425	304	166	240	9	8	41	9	0	1	0
Chironomids	946	1187	434	963	1918	142	1436	2299	644	866	1735	51
Oligochaetes	54	160	9	53	148	60	105	260	79	52	467	63
Sphaeriids	249	746	62	314	721	38	272	1137	38	41	659	15
Gastropods	21	113	70	23	41	6	17	16	0	0	0	0
Miscellaneous*	47	117	62	22	43	4	12	108	13	23	39	3
Total numbers	2080	3748	941	1544	3107	259	1848	3860	783	983	2902	132
Total wet weight, grams	14.2	26.2	10.9	20.6	28.1	3.0	56.1	59.5	25.0	29.0	43.0	26.0

* Includes ostracods; *Chaoborus*, ceratopogon, beetle, caddis fly, horsefly and *Gordeus* larvae; dragonfly, damselfly, and mayfly nymphs; leeches and nematodes.

Johnson (1968) reported the presence of 17 species of fish in Dore Lake and listed the following 16 species suggesting that two types of ciscoes are present:

Lake whitefish -	*Coregonus clupeaformis*
Cisco -	*Leucichthys* sp.
White sucker -	*Catostomus commersoni*
Longnose sucker -	*Catostomus catostomus*
Northern pike -	*Esox lucius*
Walleye -	*Stizostedion vitreum*
Yellow perch -	*Perca flavescens*
Burbot -	*Lota lota*
Emerald shiner -	*Notropis atherinoides*
Spottail shiner -	*Notropis hudsonius*
Fathead minnow -	*Pimephales promelas*
Longnose dace -	*Rhinichthys cataractae*
Brook stickleback -	*Eucalia inconstans*
Ninespine stickleback -	*Pungitius pungitius*
Logperch -	*Percina caprodes*
Iowa darter -	*Etheostoma exile*

Our study confirmed the presence of 15 species identified by Johnson. Missing in our samples were longnose dace, a few of which were captured by poisoning in Bazill Bay in 1965. Also missing were large size ciscoes.

4.4.2 Fish Populations

A review of the relative abundance of fish caught in a limited seining and trapnetting effort (Tables 10 and 11) showed the forage fish being dominated by yellow perch (53.8% of seine hauls and 37.9% in trap nets). Next in order of abundance in seine hauls were emerald shiners and fathead minnows. Fathead minnows were almost as common as yellow perch in the trapnet catches.

Table 10. Seine net catches, Dore Lake, 1986.

Location	Date	Yellow Perch	Log Perch	Emerald Shiner	Spottail Shiner	Fathead Minnow	White Sucker	Long-nose Sucker	Brook Stickle-back	Nine-spine Stickle-back	Iowa Darter
Spider Island	July 9/86	400	34	0	6	20	0	0	0	9	8
South Bay	July 8/86	46	0	0	0	2	0	0	0	0	67
Tower Beach	July 10/86	140	10	246	12	29	1	0	0	0	1
Michel Pt.	July 10/86	101	20	1	9	42	1	1	23	1	18
Tower Beach Campground	July 10/86	85	12	25	2	57	6	1	0	0	0
Total		772	76	272	29	150	8	2	23	10	94
Percent of total		53.8	5.3	18.9	2.0	10.4	0.5	0.1	1.6	0.6	6.5

Table 11. Trapnet catches, Dore Lake, 1986.

Location	Date	Yellow Perch	Log Perch	Emerald Shiner	Spottail Shiner	Fathead Minnow	White Sucker	Long-nose Sucker	Brook Stickle-back	Nine-spine Stickle-back	Iowa Darter
Bazill Bay	July 7/86	3	0	3	1	3	0	0	4	9	0
Dore River	July 18/86	0	0	2	0	6	0	0	10	2	0
Bazill Bay - west	July 9/86	23	0	4	4	160	0	0	12	24	2
Sled River	Aug. 2/86	1	0	0	0	1	0	0	21	0	0
Bazill Bay	Aug. 2/86	18	1	0	0	2	0	0	5	1	0
Bazill Bay	July 24/86	46	0	0	0	5	0	0	7	2	0
South Bay	July 25/86	101	0	9	8	0	0	0	4	2	0
Total		192	1	18	13	177	0	0	63	40	2
Percent of Total		37.9	0.2	3.5	2.6	35.0	0.0	0.0	12.4	7.9	0.4

Johnson (1968) reported a tremendous increase in numbers of yellow perch between 1956 and 1965. Our data suggest that the relative abundance of this species continues to be high. By contrast, spottail shiners which were the most numerous minnow in seine hauls in 1965 (30.2%) made up only 2% of the seine hauls in the present study. These appear to have been replaced by emerald shiners which have increased in relative abundance from 3.1% to 18.9%. Other changes in abundance of forage species include a decrease in sucker fingerlings from 18% to less than 1% and an increase in brook stickleback from only one specimen in 1965 to 12.4% of the total trapnet catches. Similarly, Iowa darters have increased from one specimen in 1965 to 6.5% of the seine hauls. The most significant change in the population of forage fish appears to be the reduction in spottail shiner and fathead minnow populations.

The large fish were sampled with standard gangs of nylon gillnets set for 24 hours at various locations throughout the lake (Fig. 8). Thirty-nine net sets yielded a total of 5 924 fish (Appendix 1). White suckers were the most numerous representing 41. 6% of the catch followed by yellow perch at 32.6% (Table 12). Fish of little economic importance, including white suckers, longnose suckers, burbot, yellow perch and ciscoes, made up 85.2% of the catch by numbers and 69.8% by weight.

Northern pike, walleye and lake whitefish are the only species of importance to sport and commercial fishermen. Walleye and northern pike combined represented only 5% of the total fish caught in gillnets. Whitefish represented 10% by numbers and 12% by weight.

Fig. 8 Approximate locations of standard gillnet sets, seine hauls and trapnet sets in Dore Lake 1986.

Table 12. Comparison of average catch of fish per standard gang gill net bottom set in Dore Lake, 1956 (24 set), 1965 (34 sets), and 1986 (39 sets).

	Number			Percent			Weight (kg)			Percent		
	1956	1965	1986	1956	1965	1986	1956	1965	1986	1956	1965	1986
Lake whitefish	9.2	10.6	15.2	13.6	3.4	10.0	5.2	5.1	8.1	9.2	11.5	12.0
Cisco	9.1	76.7	8.6	13.6	24.5	5.7	0.5	3.5	0.4	0.8	8.0	0.6
White sucker	8.5	27.6	63.2	12.7	8.8	41.6	7.9	14.0	35.1	14.1	31.7	52.1
Longnose sucker	0.9	1.4	6.3	1.4	0.4	4.2	1.5	1.0	5.2	2.6	2.2	7.7
Northern pike	18.2	3.3	5.9	27.1	1.1	3.9	24.2	3.4	11.0	36.8	7.6	16.4
Walleye	16.7	5.8	1.3	24.8	1.9	0.8	16.7	3.0	1.2	29.6	6.8	1.8
Perch	4.4	183.8	49.4	6.5	58.8	32.6	0.1	10.0	2.7	0.2	22.8	4.0
Burbot	0.2	3.4	1.9	0.3	1.1	1.2	0.3	4.1	3.6	0.6	9.4	5.3
All species	67.1	312.6	151.8	100.0	100.0	100.0	56.3	44.0	67.3	100.0	100.0	100.0

A comparison of average catch of fish per standard gang of gillnets is made with similar data from 1956 and 1965 (Table 12). Numbers and weight of lake whitefish are about 50% higher than they were in the previous studies. Northern pike which declined drastically between 1956 and 1965 are showing a modest recovery from an average of 3.3 per net set in 1965 to 5.9 per set in 1986. Walleye, which showed a serious decline in numbers between 1956 and 1965, continue to decline to the point where only 51 fish averaging 1.3 per set were caught during the entire summer in 1986. The population of white suckers has more than doubled in the last 20 years and presently represents the highest proportion (41.6% by number and 52.2% by weight) of all fish caught in gillnets. Longnose suckers are also on the increase from 1.4% of the total catch in 1956 to 4.2% in 1986. Yellow perch, which are still very abundant (32.6% of total numbers caught) in Dore Lake have undergone a reduction from an average of 183.8 per net set in 1965 to 49.4 per set in the present study.

Total numbers of all fish caught per standard gang have declined from 312.6 in 1965 to 151.8 in 1986 whereas the weight of fish increased from 44.0 kg to 67.3 kg. The changes are due to a drastic reduction in numbers of perch and ciscoes which contribute little to the total fish weight and an increase in suckers which weigh considerably more.

4.4.3 Fish Biology

Fish species that are relevant to the sport and commercial fisheries of Dore Lake were individually analyzed to provide information on population structure, growth rates, sexual maturity, feeding habits and vulnerability to various mesh sizes.

Northern Pike

Northern pike are presently the most abundant sport fish species remaining in Dore Lake. Of the 232 specimens caught in the course of summer gillnetting the majority were more than 50 cm long and weighed more than 1 kg. The largest specimen caught had a fork length of 95 cm and weighed 8.2 kg. As shown in the earlier section pike have increased in numbers substantially since 1965 but are well below the population numbers in 1956 shortly after the lake was made accessible to anglers.

Figure 9 compares the length frequency distribution of pike caught in each of the three studies. Generally, the distributions in each case are unimodal. In the present study the majority of pike were in the 55 to 60 cm range (1.0-1.5 kg) being on the average 10 cm longer than those caught in 1965 and 5 cm longer than the average length of specimens taken in 1956. The unimodal distribution of pike with absence of small specimens does not necessarily mean that reproductive failure is occurring since young pike are typically found in shallow and weedy shoreline areas not normally sampled by gill nets.

Two hundred and eight of the 232 specimens caught were aged using scales and cleithra as ageing media. Eighty percent of the specimens were in the two and three year age classes showing that rapid recovery of pike populations is possible under favorable spawning conditions (Fig. 10). Growth is extremely rapid, reflecting an abundance of food. Pike in their third year of growth ranged from 40 to 70 cm

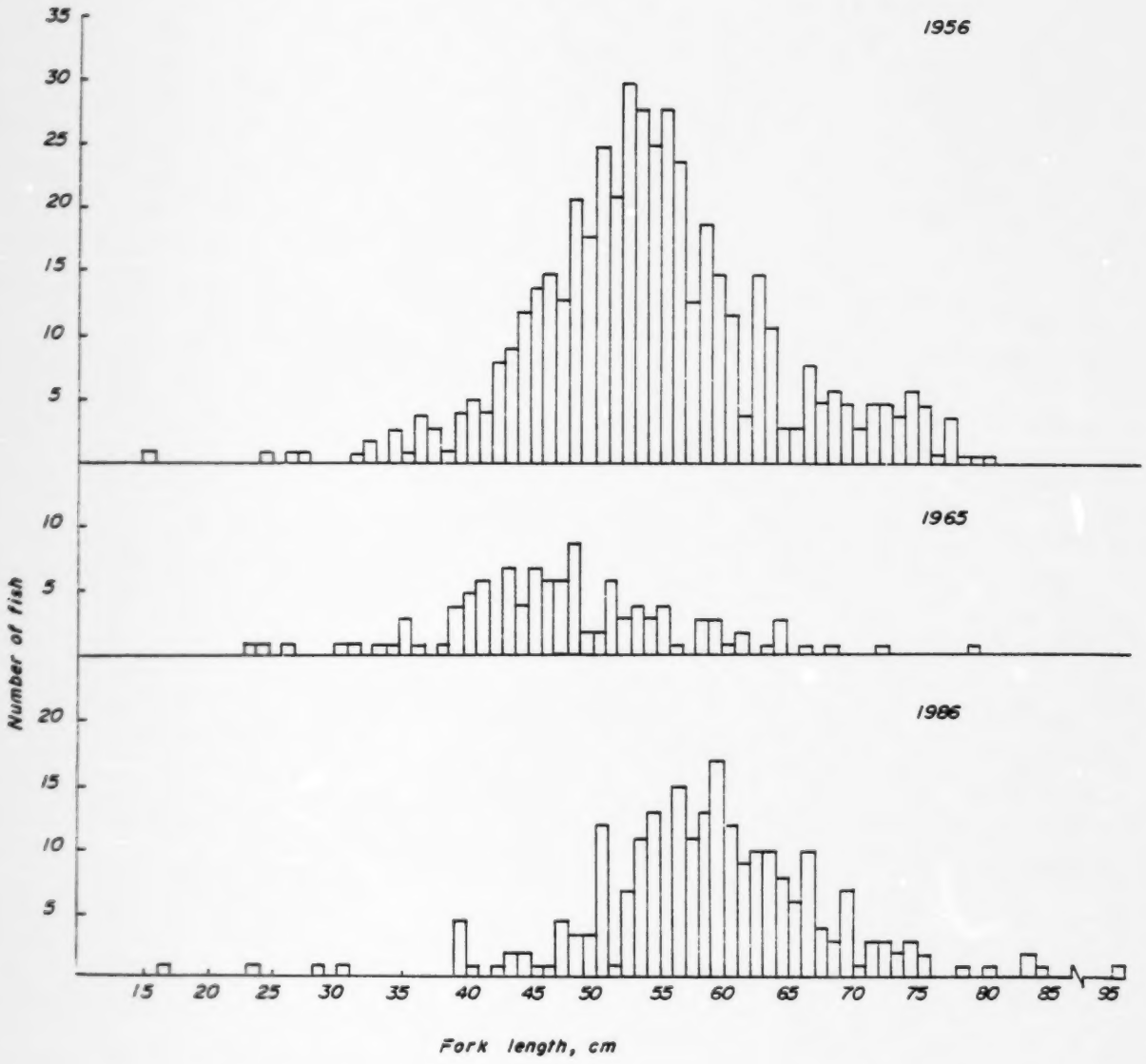


Fig. 9 Comparison of length frequency distribution of northern pike taken by standard gang gillnetting in Dore Lake, 1956, 1965 and 1986.

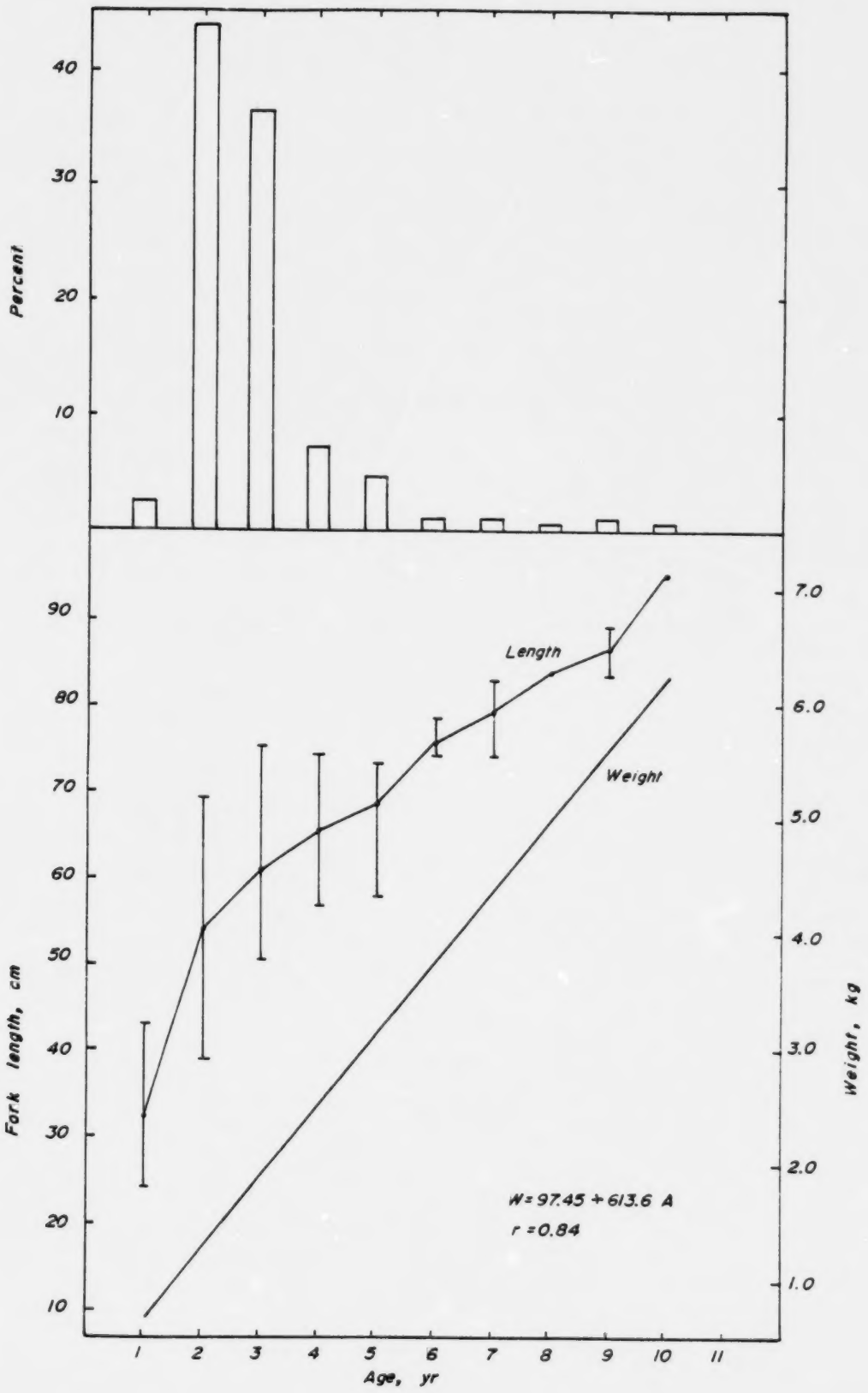


Fig. 10 Age frequency distribution and growth rate of northern pike from Dore Lake, 1986.

in length and weighed from 1 to 2.5 kg (Fig. 10). Growth rate relative to weight change is constant in the 10 year age range provided in the sample, averaging about 0.5 kg per year.

A comparison was made of pike growth rates relative to fork length in the 1965 and 1986 studies (Fig. 11). Pike were consistently larger at any given age in 1986 than in 1965 providing evidence that conditions for pike growth have improved. Incomplete data from 1956 did not permit a similar comparison with that year.

Length-weight relationships were established for Dore Lake pike and compared with data derived from 1956 and 1965 records (Fig. 12). Length-weight proportions were similar for pike smaller than 45 cm in all three studies. A progressive increase in weight per unit length is shown in the larger fish since 1956 suggesting improved conditions for pike growth.

An assessment was made of the vulnerability of northern pike to various meshes of gillnet used in the standard gang (Fig. 13). Data show that all sizes of northern pike are equally vulnerable to mesh sizes up to 7.6 cm. This results from pike becoming entangled in the meshes rather than being gilled. Frequently this occurs when pike are in pursuit of forage species such as perch and suckers which are already caught in the nets. The 10.2 cm mesh showed some selection for larger pike. Only a very small number of pike were caught in the 12.7 and 14 cm meshes.

Sexual maturity, based on recognizable gonadal development, was achieved when the fish reached 42-45 cm in fork length. At this size they would have been in their third season of growth. Of the 232 specimens caught 48% were female, 47% were male and 5% were immature specimens.

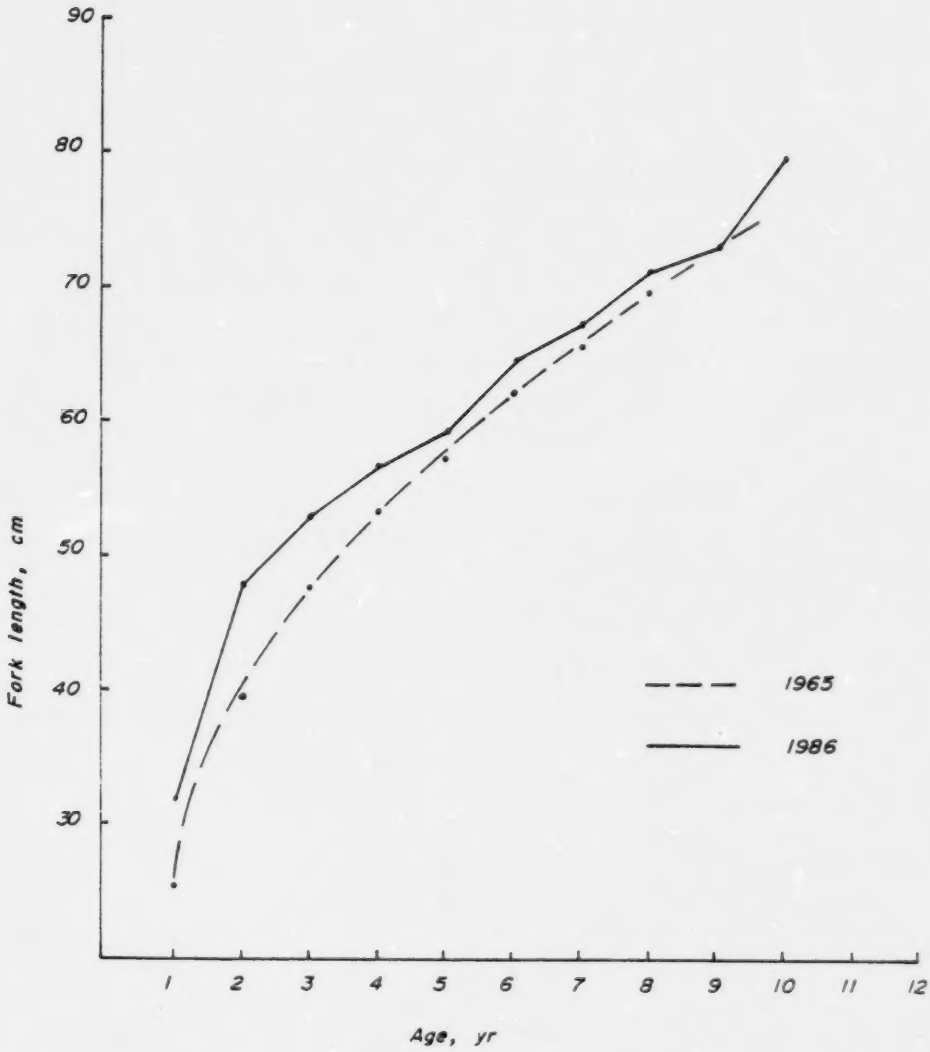


Fig. 11 Comparison of growth rates of northern pike caught in Dore Lake in 1965 and 1986.

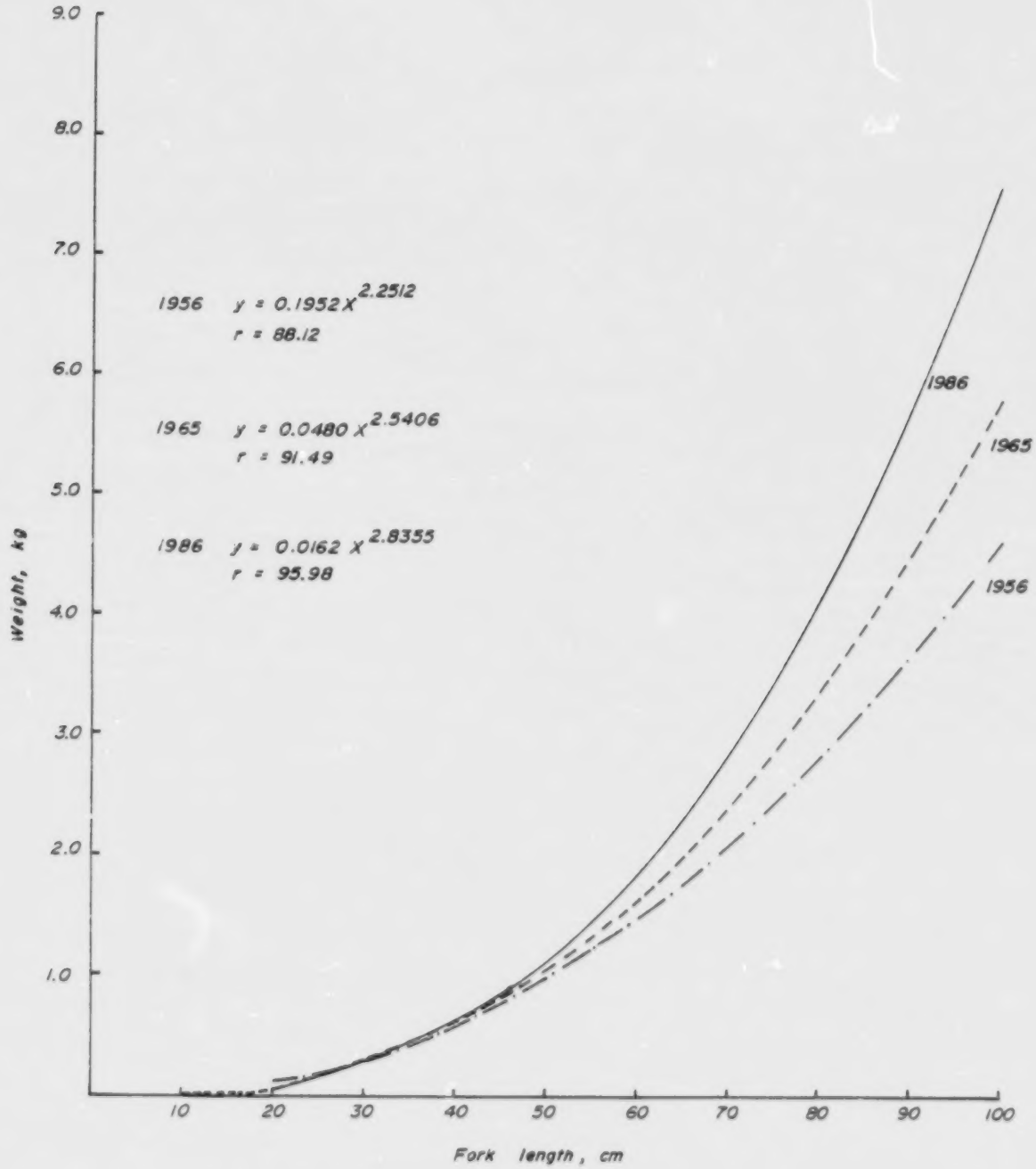


Fig. 12 Comparison of length-weight relationships for northern pike from Dore Lake in 1956, 1965 and 1986.

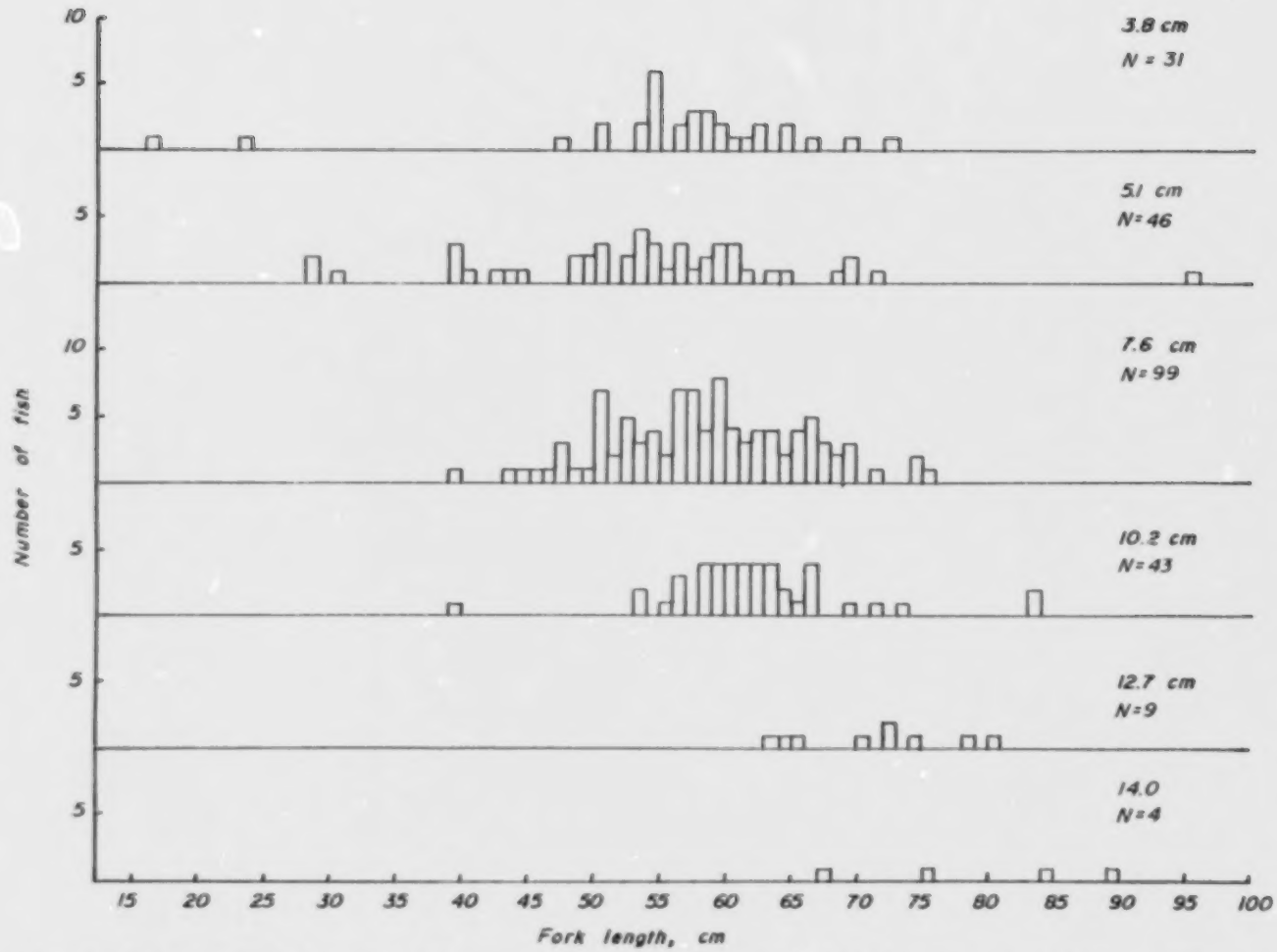


Fig. 13 Length distribution of northern pike caught by standard gang mesh 3.8 - 14.0 cm in Dore Lake, 1986.

No quantitative data were provided on the stomach contents of northern pike caught in the course of the survey. A qualitative assessment showed perch and sticklebacks as the most commonly recognized food items. Some ciscoes were found in the stomachs of fish caught in deeper water. Suckers and burbot were rarely eaten. Many of the stomachs contained fish remains that were too digested to be recognizable.

An unusually small number of pike had empty stomachs. These were frequently associated with tapeworm infestations. Northern pike are opportunistic feeders. Indications are that the larger population of perch is providing an abundant food supply for this species.

Walleye

The disappearance of walleye from Dore Lake was the main purpose for this investigation. The study confirmed the presence of only a very small population of walleye with only 51 caught in the standard test netting program during the entire summer. A plot of their length frequency distribution (Fig. 14) shows the majority of these specimens having a fork length of more than 30 cm. These fish generally ranged from 3 to 5 years in age (Fig. 15) based on ages determined from otoliths. Only six small fish ranging in size from 16 to 20 cm were caught. These represent walleye which were just over 1 year old. By contrast the majority of the 191 walleye caught in 1965 were smaller. They represented two groups, one of 5-7 year old fish ranging from 30 to 43 cm and a second group ranging from 20 to 30 cm. The latter would have represented fish younger than 4 years. In 1956, at least three cohorts of walleye were represented in the

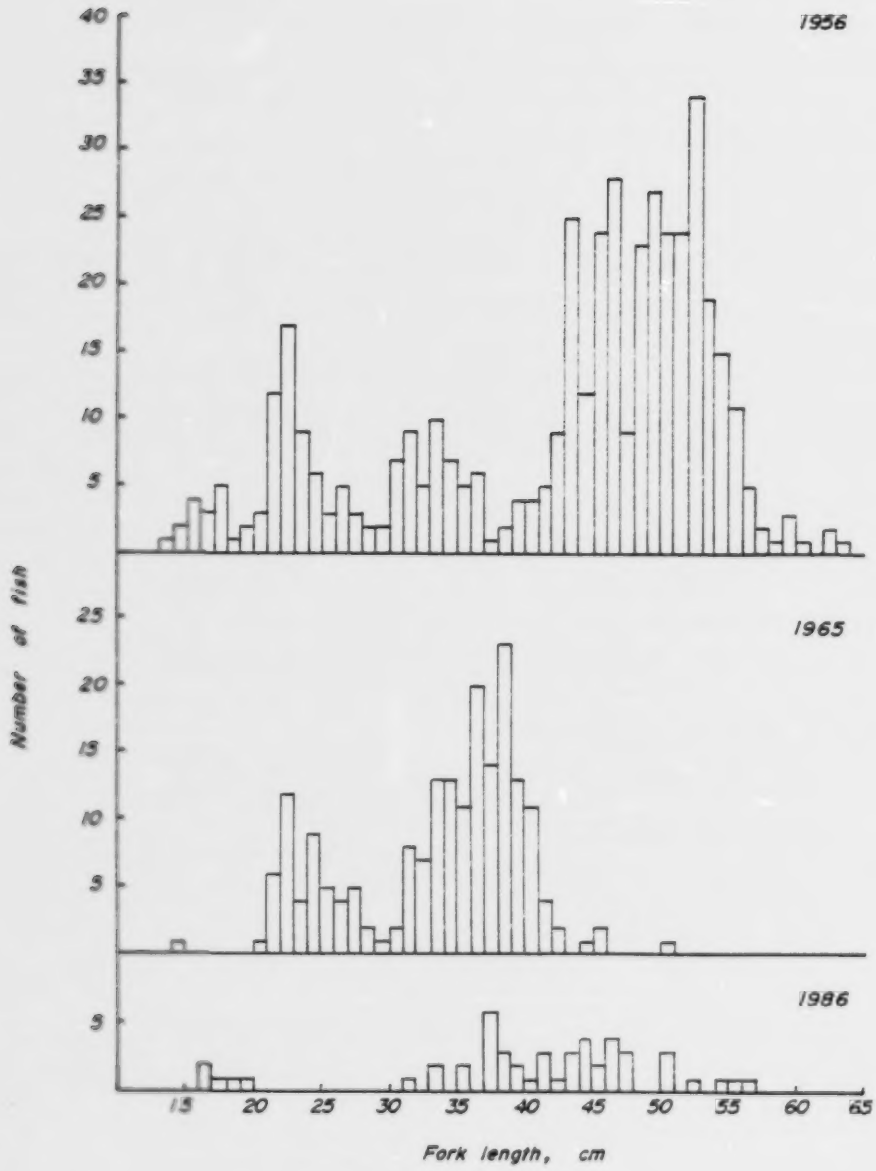


Fig. 14 Comparison of length frequency distribution of walleye taken by standard gang gillnetting in Dore Lake, 1956, 1965 and 1986.

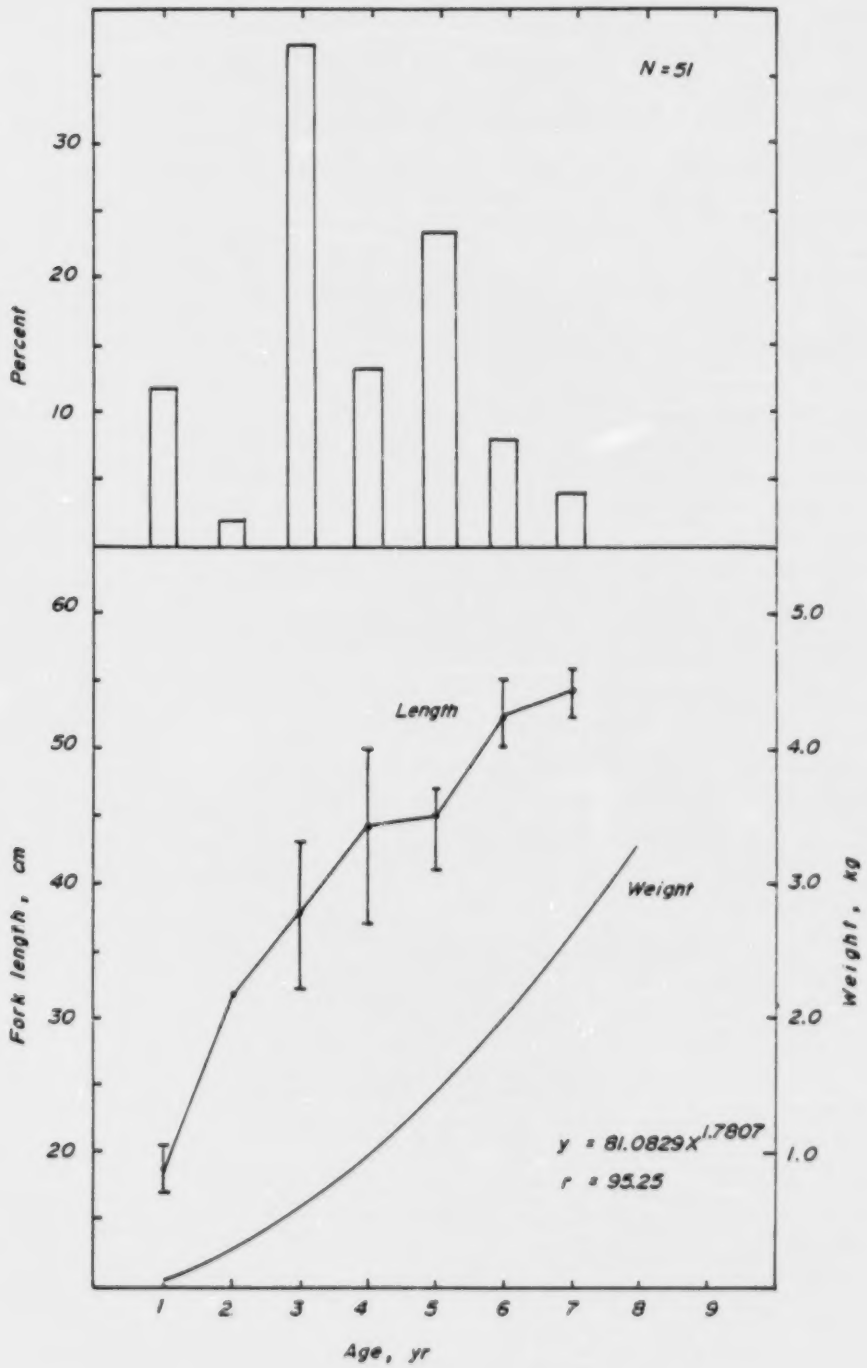


Fig. 15 Age frequency distribution and growth rate of walleye from Dore Lake, 1986.

sample of 444 specimens (Fig. 14). The majority were large fish exceeding 40 cm in fork length and ranging in age from 9-11 years. The data suggest gradual recruitment failure the beginning of which probably predates the 1956 study. The absence of large specimens in the latter two studies reflects the effects of heavy fishing pressure.

Age frequency distribution and growth rates of walleye caught in 1986 are shown in Fig. 15. Walleye grow rapidly in the first four years, increasing in length from 5-10 cm per year and 0.25-0.4 kg in weight. A reduction in length increase in subsequent years is compromised by a proportional gain in weight of approximately 0.5 kg per year. A reduction in growth in length at the age of four coincides with the reaching of sexual maturity. The fish continue to gain weight during this period.

A comparison of walleye growth rates in the 1956, 1965 and 1986 studies (Fig. 16) indicates that drastic changes in walleye growth have taken place over the 30 year period. Fish now take 3 to 5 years less time to achieve catchable size than they did in 1956 resulting in a large proportion of relatively large walleye vulnerable to angling and commercial gillnetting still being immature. The 1965 growth curve suggests that growth rate in walleye began to increase in the early 1960s. As a result of the rapid growth rate, walleye life span in Dore Lake has been considerably shortened. The oldest fish caught were 7 years with the majority in the 3 to 5 year classes. In 1956 21% of the walleye catch was older than 7 years; in 1965 only 7% exceeded 7 years. The increased growth rate demonstrated by the walleye is a typical response to severe fishing pressure.

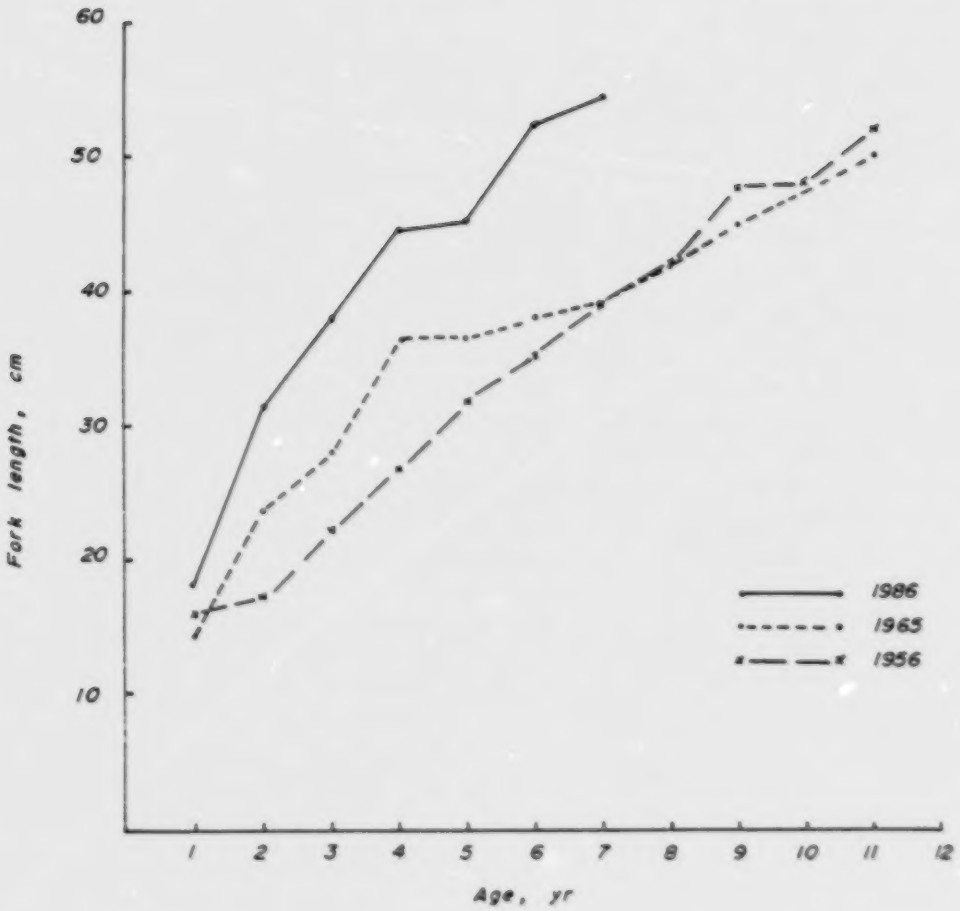


Fig. 16 Comparison of growth rates of walleye caught in Dore Lake, 1956 1965 and 1986.

Length-weight relationships were established for walleye based on the 51 fish caught. In spite of the small sample a high degree of correlation was established between the calculated curve and the data set. Comparisons of the length-weight relationships with those calculated from data derived in 1956 and 1965 are provided in Fig. 17. Length-weight relationships for 1965 and 1986 are virtually identical. The larger fish caught in 1956 tended to weigh less per unit length than in the latter studies suggesting that conditions for walleye growth were less suitable perhaps due to overcrowding and lack of food.

Sexual maturity of walleye based on the state of gonad development, were determined for each specimen. Mature females outnumbered males by 1.29:1. Sixty-five percent of the walleye caught were immature. Sexual maturity is achieved when the fish are 42-45 cm long at which time they weigh between 1 and 1.2 kg. Lengths and weights of mature females extend from the upper ends of these ranges whereas males tend to mature earlier. Walleye at these lengths and weights range in age from 4 to 5 years.

The vulnerability of walleye to various mesh sizes was determined from the gillnet catches (Fig. 18). Because of the small number of fish caught and the narrow range in size distribution of the majority of specimens, few conclusions on mesh selectivity can be drawn. It is reassuring to note that all of the walleye caught in the 12.7 cm (5 inch) mesh would have been mature. No walleye were taken in the 14 cm (5½-inch) mesh.

Stomach contents of all of the walleye caught were examined to determine their feeding habits in Dore Lake. Thirty-six of the

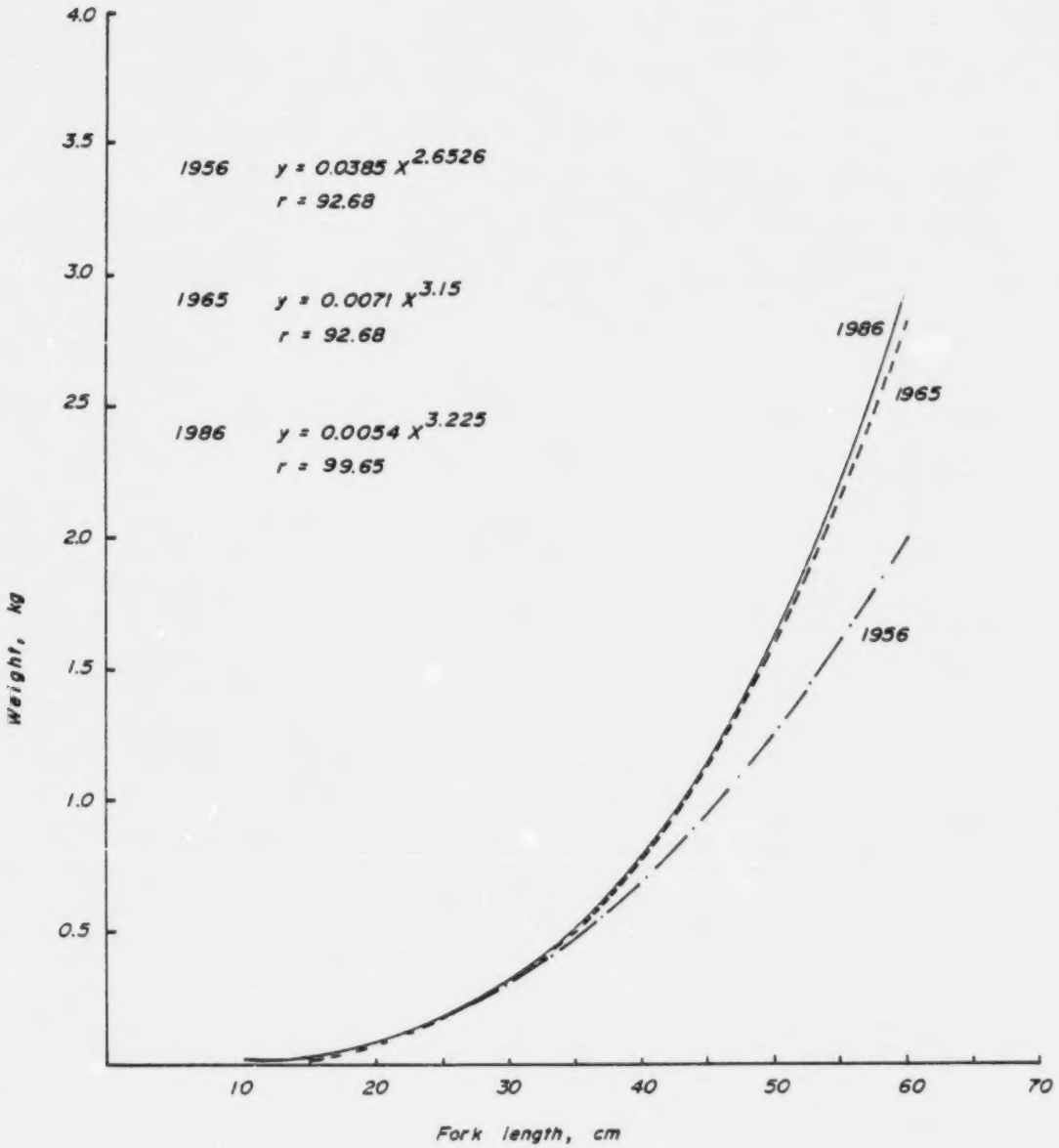


Fig. 17 Comparison of length - weight relationships for walleye from Dore Lake in 1956, 1965 and 1986.

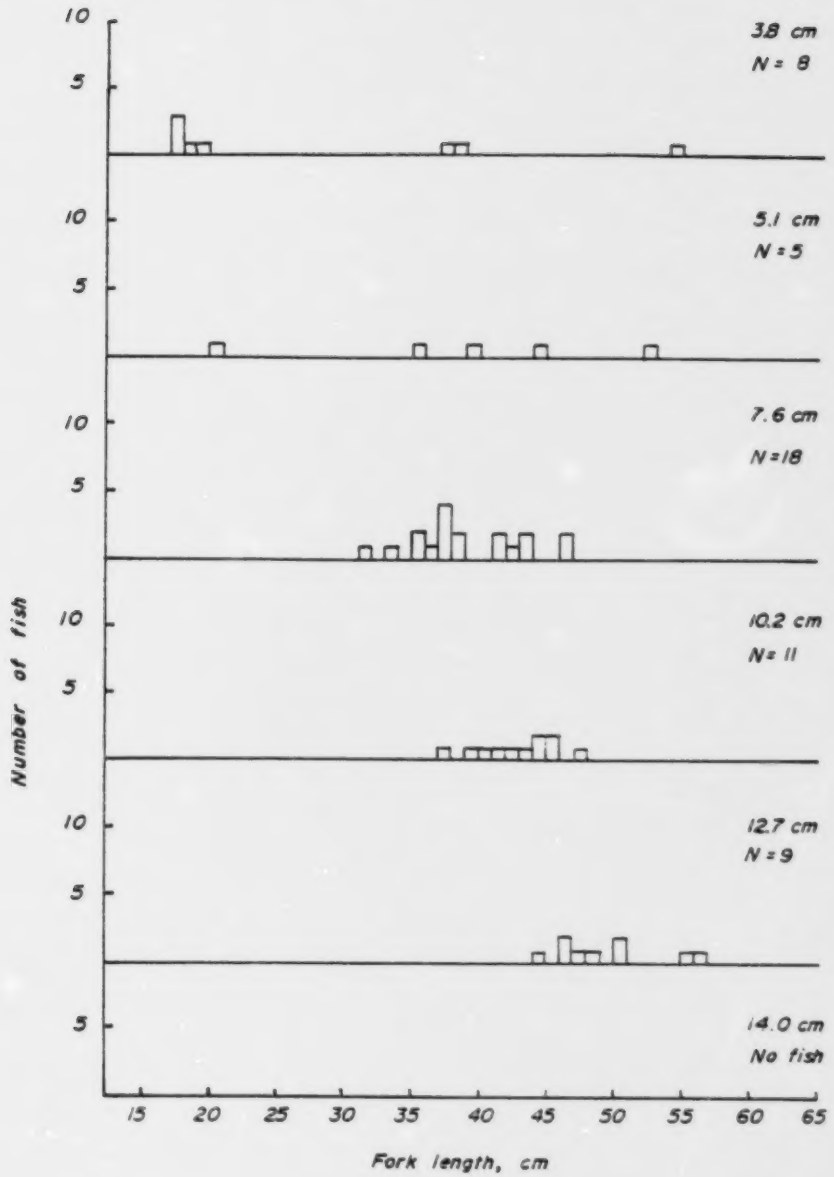


Fig. 18 Length distribution of walleye caught by standard gang mesh 3.8 - 14.0 cm in Dore Lake, 1986.

51 fish had food items in their stomachs; all were fish remains. In 28 of the fish the stomach contents were digested to the point where species identification was no longer possible. In the remaining walleye, ciscoes and suckers were most commonly consumed along with some perch, whitefish and sticklebacks.

Lake Whitefish

Lake whitefish represent the mainstay of the Dore Lake commercial fishery with an average of 210 000 kg being taken annually in the period of record extending from 1920. A total of 593 whitefish were caught in the present study, averaging 15.2 per net set and representing 10% of the total catch. A plot of the length frequency distribution of whitefish caught (Fig. 19) shows a bimodal distribution with a strong population of fish ranging in size from 30 to 42 cm in length. A smaller peak of young fish indicates good reproductive success. A comparison of length frequencies with those obtained in 1965 shows a similar number of small fish but smaller numbers of mature specimens. Contrasting with these results, the population of whitefish sampled in 1956 was small with the majority of fish being mature. Absence of small fish suggested recruitment failure.

Age determinations were carried out on a maximum number of 10 specimens per cm of length using scales and otoliths as ageing media (Fig. 20). In cases of discrepancies between the two media otolith ages were selected as being more accurate for older fish. Whitefish caught in Dore Lake ranged from 1 to 12 years. Relative proportions of fish in various age classes based on the above subsample are shown in Fig. 20. The majority of fish aged ranged from 2 to 6 years of

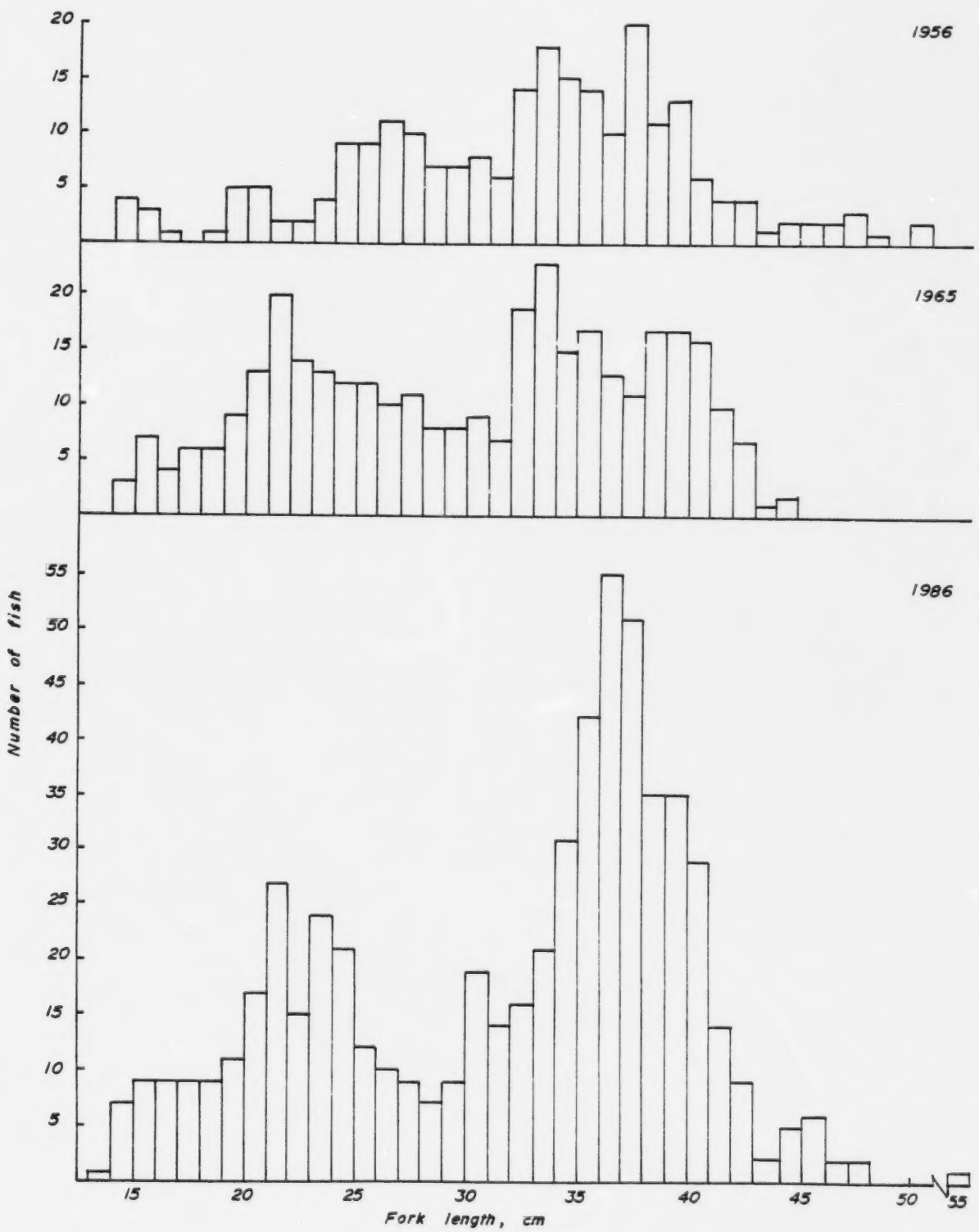


Fig. 19 Comparison of length frequency distribution of lake whitefish taken by standard gang gillnetting in Dore Lake, 1956, 1965 and 1986.

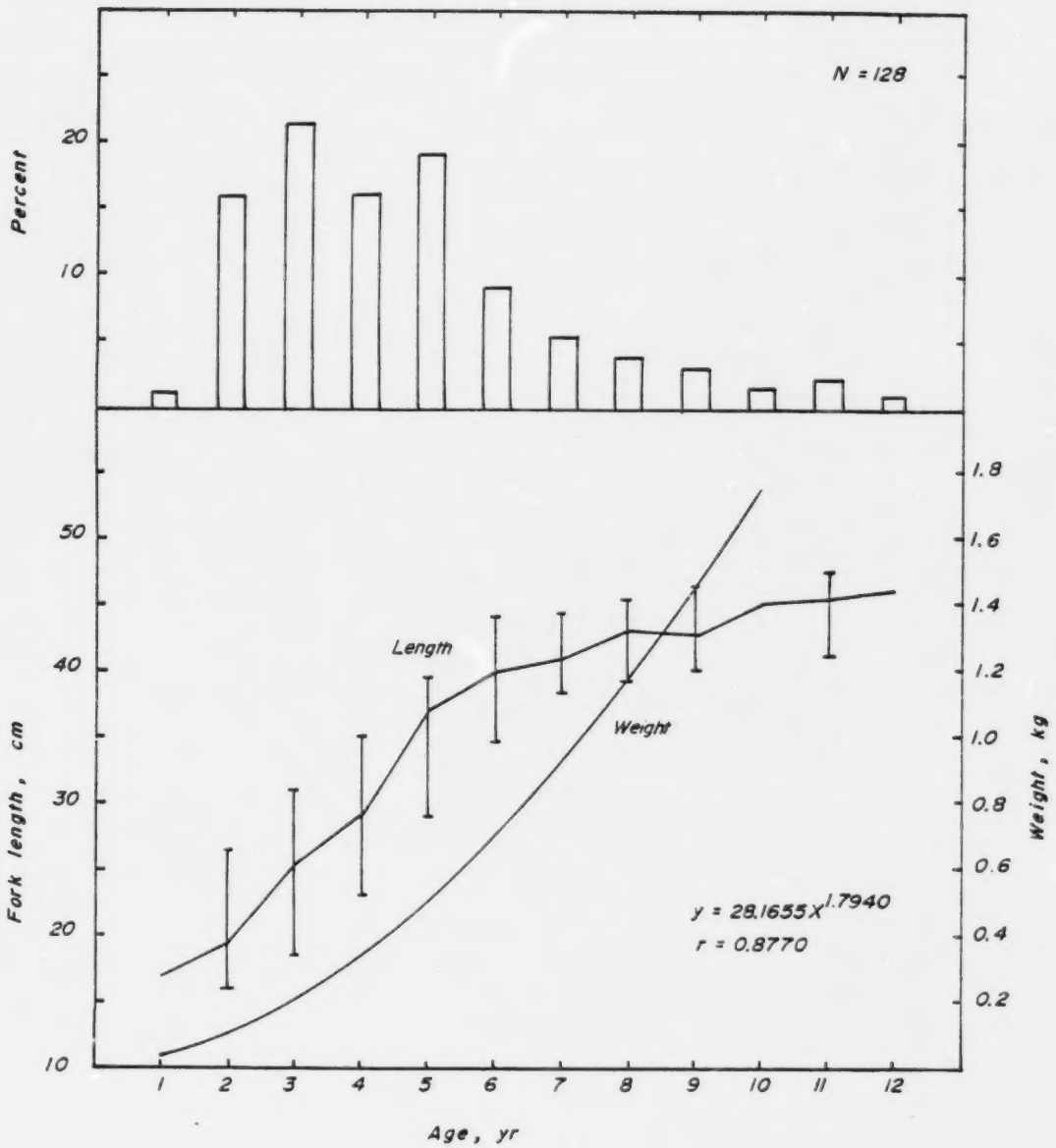


Fig. 20 Age frequency distribution and growth rate of lake whitefish from Dore Lake, 1986.

age. Comparison of the data with the length frequency distribution shown in Fig. 19 indicates that the bulk of the harvestable population is from the 5 and 6 year classes. Lack of significant numbers of older fish reflects recruitment failure for several years in succession prior to 1981-82, heavy fishing pressure or a combination of both. The data suggest a relatively weak population of 4 year olds followed by strong classes of 2 and 3 year old whitefish.

Growth rates based on fork lengths and weights of aged specimens are presented in Fig. 20. Growth curves suggest progressive increases in both length and weight throughout the entire life span. Mean lengths indicate that growth slows considerably after the fifth year, the age at which sexual maturity is achieved.

The average fork length in each year was compared with data on Dore Lake whitefish of similar age compiled by Johnson (1968) (Table 13). Except for the length of 4 year old whitefish average lengths of all ages reported in 1986 were in the range of average lengths caught in biological surveys and commercial fishery samples since 1949. Four year old fish caught in 1986 were smaller than the average reported in previous years.

Length-weight relationships for the whitefish population were established from the data collected from each specimen (Fig. 21). These were compared with similar data derived from the two earlier studies. The majority of whitefish collected ranging up to 35 cm in length had similar length-weight proportions. Fish larger than 35 cm were heavier per unit length in 1965 than in the present study. The small numbers of long, slender fish caught in 1956 may suggest that food availability to whitefish may be a critical factor regulating the population of this species.

Table 13. Average fork length at each age of whitefish in Dore Lake from 1949 to 1986 (number of samples in brackets).

Year	Source	1	2	3	4	5	6	7	8	9	10	11	12	13
1949	Commercial cyst infestation samples (Aug.)					41.1 (2)	42.7 (14)	42.7 (16)	44.5 (3)					
1951	Commercial cyst infestation samples (Feb.)				36.1 (1)	38.6 (1)		41.1 (21)	42.2 (3)	43.7 (2)				
1956	Biological survey samples		21.6 (4)	25.7 (7)		41.1 (2)		42.4 (1)						
1965	Commercial fishery samples (Feb.)						40.9 (13)	41.4 (8)	44.2 (9)	43.7 (1)				
1965	Biological survey samples	15.5 (6)	19.3 (15)	25.7 (15)	31.5 (7)	34.5 (13)	37.8 (16)	40.9 (9)	41.7 (6)					
1967	Commercial fishery samples (June)					36.6 (22)	38.1 (66)	40.4 (70)	41.4 (35)	42.7 (11)				54.6 (2)
1967	Commercial fishery samples (Sept.)				39.4 (2)	38.4 (50)	39.9 (66)	41.4 (37)	42.4 (16)	41.1 (1)	47.5 (1)			
1986	Biological survey samples	17.0 (1)	19.5 (21)	25.6 (28)	29.1 (21)	37.0 (24)	39.8 (12)	41.0 (7)	42.9 (6)	43.2 (4)	45.0 (1)	45.4 (3)	46.8 (1)	

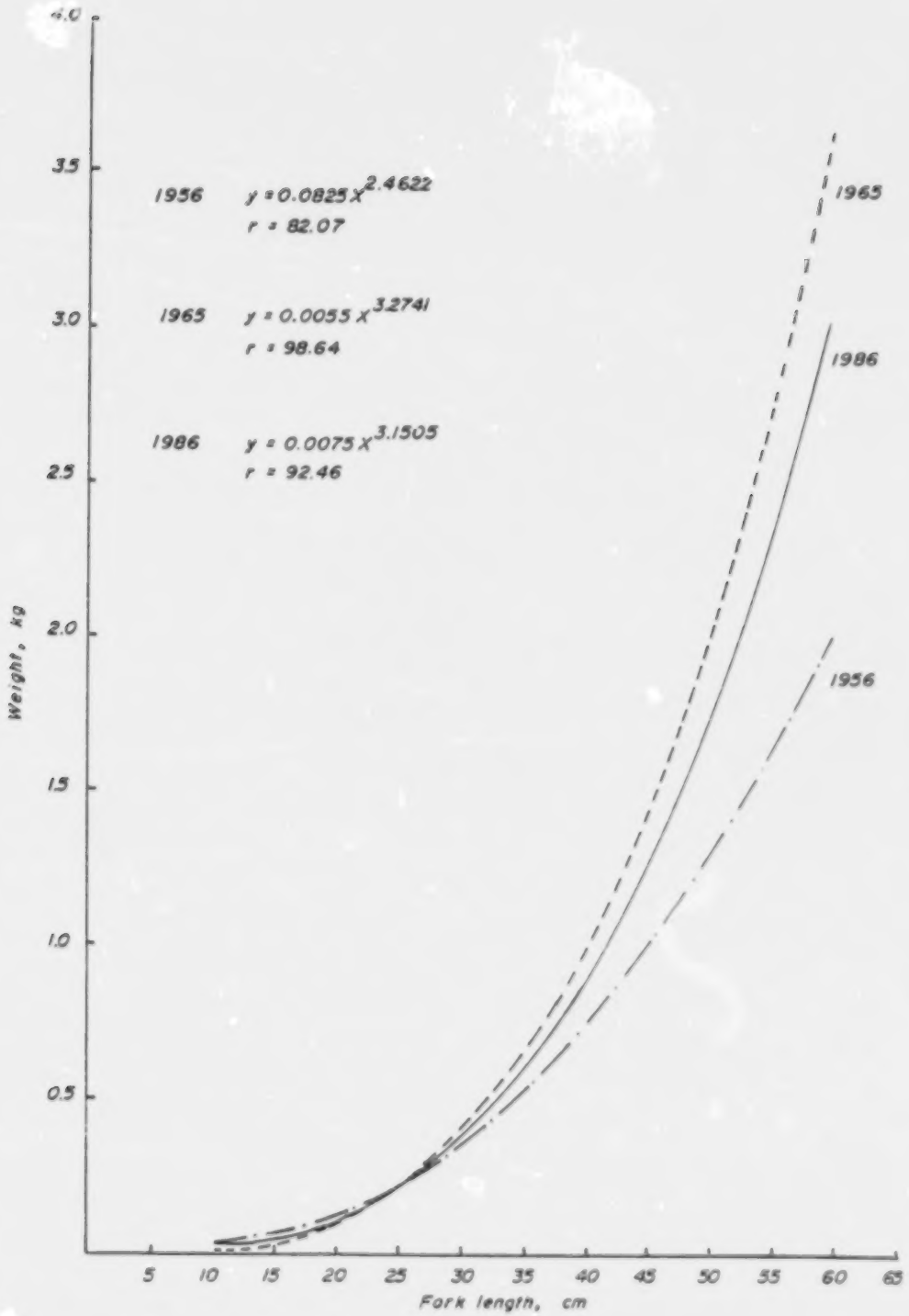


Fig. 21 Comparison of length-weight relationships for lake whitefish from Dore Lake in 1956, 1965 and 1986.

Female whitefish reach sexual maturity at a fork length of 35.5 to 36.0 cm. At this length they generally weigh from 550 to 600 g. Males mature when they are somewhat smaller, generally ranging from 33 to 34 cm in length and weighing 450-550 grams. Age at sexual maturity is 5 to 6 years.

The diet of whitefish from Dore Lake is characteristic of this species in other lakes and in the earlier studies. As bottom feeders whitefish consume primarily chironomid larvae and sphaeriid clams in the deep water. In the shallow water they feed on amphipods, *Chaoborus*, caddisfly larvae, water boatmen (Corixidae), leeches and snails.

The vulnerability of whitefish to various mesh sizes was determined from the gillnet catches (Fig. 22, Appendix II). Fish vulnerable to the 3.8 cm mesh size are predominantly in the 15-20 cm length range. A small number of larger fish are also caught. These are generally entangled rather than gilled. Whitefish gilled in the 5 cm mesh range from 19 to 28 cm. The majority of whitefish caught in the 7.6 cm mesh ranged upwards from a 30 cm fork length with a smaller number of fish from 24 to 30 cm also being taken. The 10.2 cm mesh caught a total of 162 fish ranging upwards from 33 cm; the majority were 36 cm. On the basis of their length very few fish caught in this mesh would be sexually immature.

The 12.7 cm mesh caught a considerably smaller number of whitefish than the smaller mesh sizes. The majority of the 42 specimens ranged from 39 to 46 cm and would have weighed more than 750 g (1.6 lb) each. Only 7 larger whitefish were caught in the 14 cm mesh.

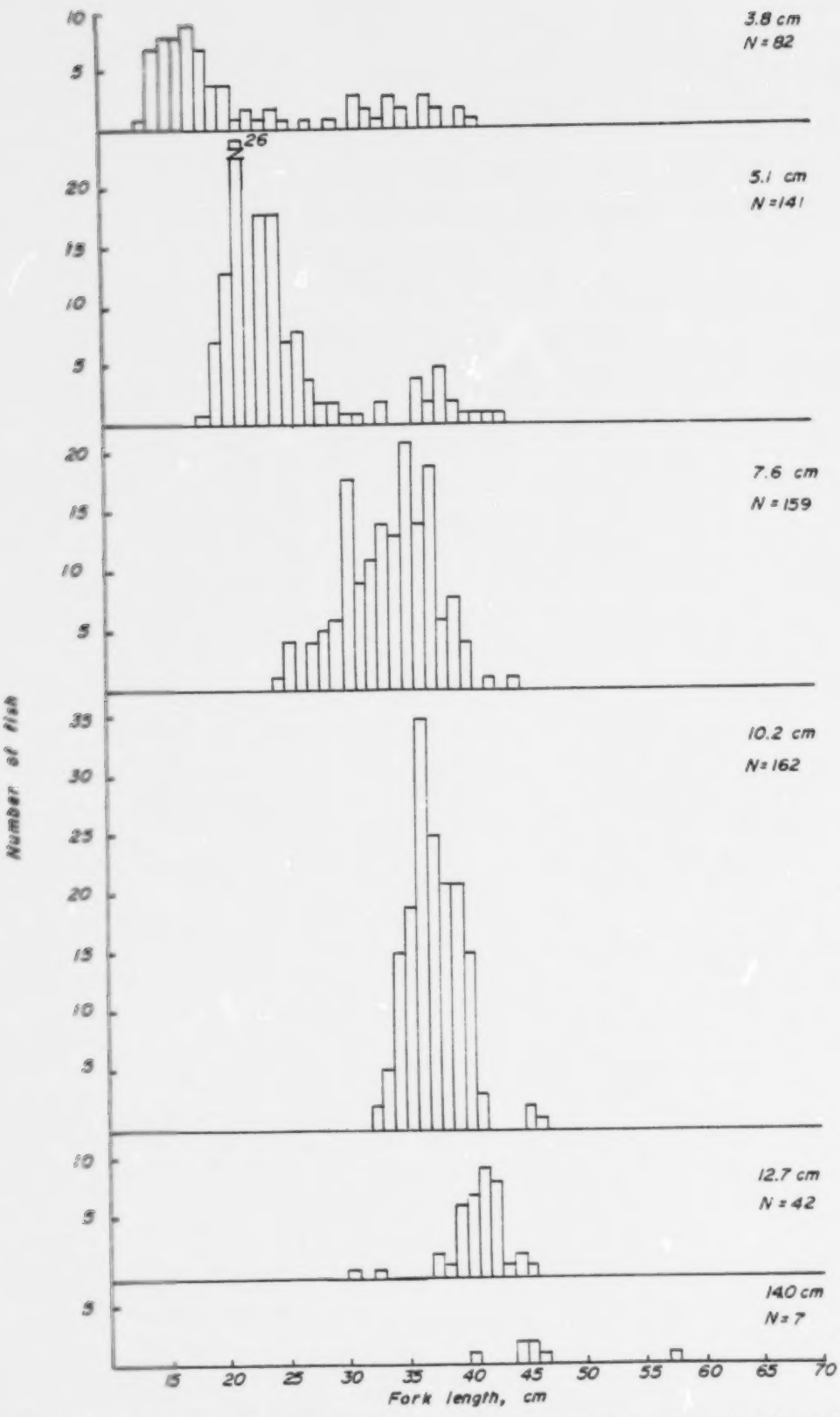


Fig. 22 Length distribution of lake whitefish caught by standard gang mesh 3.8 - 14.0 cm in Dore Lake, 1986.

Other Fish Species

Included in this category are fish species which are not normally utilized by commercial and sport fishermen. In Dore Lake these included yellow perch, ciscoes, white suckers, longnose suckers and burbot. Since the main objectives of this study were to assess the stock of commercial and sport fish species, detailed analysis of the length, weights, ages, stomach analyses and sex of individual fish specimens of these species were not undertaken.

4.5 FISH UTILIZATION

4.5.1 The Commercial Fishery

Johnson (1968) noted that a commercial fishery existed on Dore Lake as early as 1911 (from Prince *et al.* 1912). Commercial fish production records are available from 1920-21 when total production of 515 562 kg (1 136 000 lb) was reached (Appendix III). Average production for each decade is summarized in Table 14. Up until 1980, total fish production in Dore Lake ranged in the order of 300 000 kg per year. Two peak production periods associated with the first and second world war demands caused production to rise to more than 500 000 kg. In 1984-85 production began to slide reaching an all-time low of 98 932 kg in 1985-86. The number of commercial licenses issued ranged from a maximum of 206 in 1959-60 to only 26 in 1985-86.

Lake whitefish are the dominant species taken in commercial gillnet catches generally making up 60 to 75% of the catch. Since 1979 the yield of whitefish has been in excess of 75% of the total catch. With two exceptions (1953-54 and 1974-75) consistently high

Table 14. Average commercial fish production (kg x 10^3) in Dore Lake in each decade of recorded fishery operations.

	Whitefish	Walleye	Pike	Other	Total
1920 - 1930	232.4	28.2	35.0	48.1	343.7
1931 - 1940	196.5	36.6	34.9	20.1	288.1
1941 - 1950	203.0	97.7	70.8	24.1	395.6
1951 - 1960	234.0	61.2	24.7	5.5	325.4
1961 - 1970	187.3	79.7	26.0	24.8	317.6
1971 - 1980	235.4	36.2	16.1	26.0	313.7
1981 - 1987	169.9	12.2	21.0	0.8	203.9

catches of walleye were taken from Dore Lake until 1977-78. Since then production has become erratic and has gone as low as 261 kg (1981-82). In the last three years walleye production has been less than 10 000 kg. The recent poor catch of walleye has been somewhat compensated by harvests of pike in excess of 20 000 kg per year. Production of rough fish has fluctuated widely during the period of record, being highest in earlier years when markets for these species were more readily available.

The present commercial fishery on Dore Lake is shared by two fishermens' co-operatives, Beauval and Dore Lake. At present Dore Lake fishermen outnumber those from the Beauval co-operative by a small margin as shown in Table 15.

Table 15. Numbers of commercial fishermen operating on Dore Lake in the 1986-87 season.

	Eligible	Licensed	Active
Dore Lake	19	16	13
Beauval	14	12	10

The annual commercial fish quota has been set at 272 100 kg, including whitefish, pike and walleye, with 181 400 kg allocated for a summer fishery and 90 700 kg for a winter fishery. There are no separate species quotas or established game fish tolerances. This quota has been in effect since 1968 when it was reduced from 317 500 kg. The summer fishery extends from breakup until September 15 (closing date variable); the winter fishery begins when ice forms in November

and extends to March 31. A mesh size of 12.7 cm is presently in effect on Dore Lake with a limit of 1830 m (2000 yards) of net per fisherman.

Johnson (1968) undertook an analysis of the relative proportions of whitefish, walleye and pike caught in the summer and winter fisheries. "On the average there is considerably more whitefish (76%) in the winter catch than during the summer (59%). The catch of walleye in the winter drops to 11% from the summer catch of 35%. The winter catch of pike increases to 11% from the summer catch of 6%".

The "summer" fishery is generally divided into two periods. The spring fishery which begins when the ice leaves the lake near the end of May excludes the area of Bazill Bay in the southwest part of the lake. This exclusion was put in place to protect the declining walleye population which traditionally have been known to use the Sled River as a spawning area. Johnson noted that few walleye were taken in the 1967 spring fishery even before the exclusion of Bazill Bay. He speculated that the spawning run had already dispersed by the time commercial fishing began, one week after breakup.

A large proportion of walleye are taken in the fall fishery which begins in August and extends to September 15 (Table 16). The large catches of walleye are taken in the northeast part of the lake where movement of fish into the area appears to be associated with the disappearance of summer stagnation as lake temperatures drop.

Commercial sampling of walleye catches was undertaken in the last week of August, 1987, to determine the length, weight and age distribution of fish being harvested.

Table 16. Breakdown of commercial walleye catch by month, Dore Lake, 1986-87.

	Walleye Catch (kg)		Walleye Catch (kg)
April	0	October	0
May	0	November	63.2
June	619.0	December	163.7
July	326.4	January	2.0
August	1954.0	February	0
September	5207.0	March	0

A random sample of 100 walleye ranged from 39 cm to 54 cm in fork length and 675 g to 2050 g in total weight. The majority of the walleye were in the 44-50 cm range, weighing 1200 to 1500 g. These fish would have been 4 years and older.

Johnson (1968) speculated that under normal conditions Dore Lake should sustain a commercial production of walleye of at least 90 700 kg (1.5 kg/ha) but noted that in the past production from the lake had consisted of large old individuals. He suggested that the harvest of smaller younger fish would allow a faster rate of turnover of the crop and greatly increase possible production. In fact, the fishing pressure on Dore Lake has eliminated the older fish; the oldest fish caught in this study were only 7 years of age. It has caused the walleye to grow much more rapidly as predicted by Johnson. In spite of this the walleye population cannot support the fishing pressure placed on it by the commercial fishermen and anglers and is on the verge of total collapse. The main cause of this condition is the fact the accelerated growth rate has caused the walleye to become vulnerable to angling and commercial fishing before they have had a chance to achieve their reproductive potential.

Johnson (1968) suggested that the rich bottom fauna and sufficient plankton production should provide for greater sustained whitefish production than in the past, possibly in the order of 4.5 kg/ha (272 160 kg). This figure was used to establish the total quota for the lake. Recent fluctuations in the whitefish harvest suggest that Johnson's recommendation might be somewhat optimistic but the use of this figure as a total lake quota is not detrimental to the

whitefish fishery since much of the fluctuation appears to be reflection of prices, pricing policy and fishing effort rather than availability of fish.

With the decline of walleye, northern pike has become an important second species in the commercial fishery at Dore Lake. Average annual production of pike in the past 11 years has been 22 030 kg. Johnson (1968) suggested that a pike fishery of 68 040 kg would not seem to be detrimental to the population citing the fact that a greater quantity than this was probably removed from a very limited area by mink ranchers. Although the pike population is presently strong and growth rates are exceptionally high, the absence of large, old fish in the population suggests that the population is not underutilized and is in fact recovering from a serious decline experienced in the early 1980s. A quota for pike should be conservatively set at about 20 000 kg to provide compatibility with other resource users.

4.5.2 The Mink Ranch Fishery

Mink ranching began on Dore Lake in 1940. Up to ten licenses were issued for a maximum quota of 2 000 breeding adults over a period of 15 years in the 1950s and 1960s (Johnson 1968). Disease and a lack of demand for mink pelts has caused all but one mink rancher to quit their operations by 1983. In 1985 only 275 breeding adults were being maintained. These animals consumed a total of 44 993 kg of fish in the following proportions: whitefish 7.9%, walleye 0.4%, pike 4.2%, suckers 39.9%, burbot 47.6%. The proportions of various species used as feed by mink ranchers prior to 1968 averaged 12% whitefish, 7% walleye, 40% pike, 20% suckers and 21% burbot (Johnson 1968). The

change in species composition reflect drastic increases in sucker and burbot populations and a conscious effort on the part of the mink ranchers to avoid the dwindling stocks of commercial and sport fish species. Smaller mesh nets (11.4 cm) are still permitted in the harvest of mink food in contrast with the 12.7 cm mesh required by the commercial fishermen. The mesh size used presently has been increased from the 7.6 and 10.2 cm meshes allowed in the early years of mink ranching when small mesh nets were encouraged to help control pike populations. The use of small mesh nets has always been a contentious issue among the mink ranchers, the commercial fishermen and the sport fishermen at Dore Lake leading to the illegal use of these nets by the commercial fishermen and complaints by sport fishermen that too many sport fish species were being taken. Johnson (1968) in his assessment of the Dore Lake fishery discounted the problem as being "...largely one of public relations" since in his opinion only a very small proportion of fish taken by mink ranchers were game fish species. This problem has been further diminished by the decline in numbers of mink ranchers and the increased availability of rough fish.

The illegal use of small mesh nets could, however, have a significant impact on the sport fishery, in particular, the walleye whose rapid growth rate in recent years allows them to become vulnerable to the 7.6 and 10.2 cm mesh sizes long before they reach sexual maturity. For this reason strict enforcement of the use of 12.7 cm mesh nets should be encouraged to avoid further depletion of stocks of immature walleye.

4.5.3 The Sport Fishery

Sport fishing was commercialized on Dore Lake in 1952 when the first outfitter became established. Two others joined in 1958 soon after all weather road access to the lake was developed. Two of the three outfitters were in operation at the time of the survey. These were Michel Lodge Ltd. at Michel Point and Dore Lake Lodge on South Bay. The third, Tower Lodge, reopened in the spring of 1987. Almost from the time that lodges became operational anglers and outfitters complained of poor fish catches particularly walleye. Johnson (1968) who investigated the problem for the Fisheries Branch in 1965 concluded that "...all three fisheries have been the victims of natural factors affecting the pike and especially the walleye populations". His study data suggested that angling would improve the following year and that the sport fishery would be expected to be more satisfying. The whitefish and pike fisheries recovered since 1965 and returned to normal until 1980 when another collapse of the whitefish fishery occurred (Walton 1983) as a result of a heavy infestation of the spiny-headed worm Acanthocephala of the species *Echinorhynchus salmonis*. Walleye populations continued to decline throughout this period. In the course of the decline in walleye, northern pike became the backbone of the outfitting industry. Confrontation between outfitters and commercial fishermen came to a head when greater numbers of pike than usual were taken in 1979-80 when whitefish became unavailable.

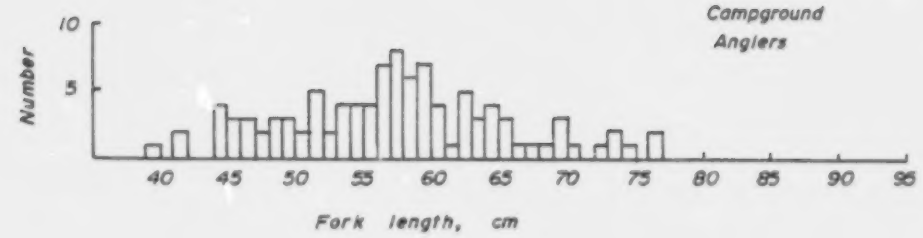
Records of sport fish catches by clients from outfitters lodges based on gut can analyses are available for Dore Lake for the summer of 1985 (see Appendix IV). The results show only 29 kg of

walleye (0.3%) out of a sample of 8 494 kg of fish caught by anglers. (*R. Orr, pers. comm.*[1]) In the course of this study samples of contents of gut cans were examined between May 31 and August 4 to determine the numbers, species proportions and sizes of fish caught by anglers. Of 721 fish carcasses examined at the two lodges then in operation, only 20 walleye were found. The remainder were northern pike. The proportions of walleye found at the public campground filletting station were higher (37 walleye, 177 pike). Thirty-six of the walleye recovered from the gut cans were measured. All walleye taken by lodge clientele ranged between 44.0 and 53.8 cm. By contrast walleye caught by anglers occupying the public campgrounds ranged from 32.8 to 46.2 cm. The majority of the latter (78.5%) were smaller than 40 cm. Data presented earlier would suggest that all of these would have been immature.

Northern pike make up by far the greatest proportion of fish caught by anglers (94%). Eighty percent of the pike examined were caught by guests of the lodges. Length frequency data provided on a sample of these fish are presented in Fig. 23. The pike ranged in length from 42 to 90 cm with the majority in the 57 to 67 cm range. All of these fish would have been mature. Comparison of length frequency distribution of pike caught by campground anglers with those caught by lodge guests shows that the latter are much more successful in catching both more and larger pike.

Discussions with lodge operators and Conservation Officers confirm that few walleye are taken and that northern pike are the mainstay of the sport fishery on Dore Lake. Most angling occurs in South Bay, East Bay and T-Bay in the northeastern part of the lake. Anglers are seldom seen in Bazill Bay which is frequented by spawning

1. R. Orr, Regional Fisheries Biologist, Prince Albert Region



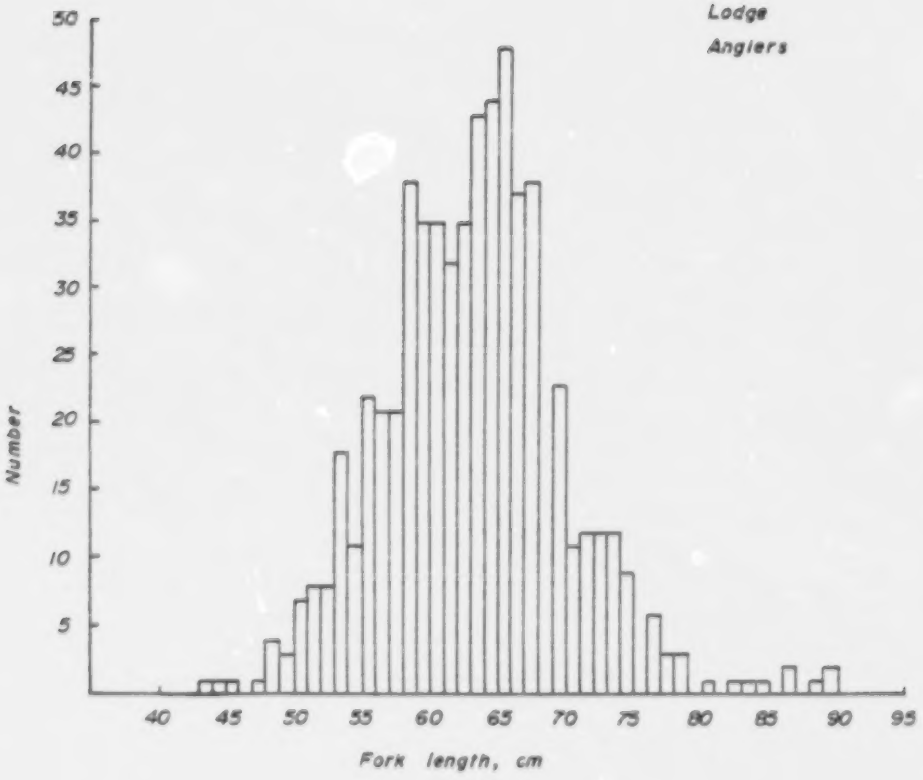


Fig. 23 Length frequency distribution of northern pike caught by lodge and campground anglers at Dore Lake, 1986.

pike and walleye. It is of some concern that walleye angling in Dore Lake is indiscriminate and that the majority of fish taken are immature.

4.6 FISH SPAWNING

Timing of this study was inappropriate to study the spawning activities of the major fish species in Dore Lake. Minnow and fry traps failed to catch any young-of-the-year fry or fingerlings. As a result none of the information on fish spawning provided from alternate sources could be confirmed.

Johnson (1968) speculated that spring concentrations of walleye in Bazill Bay were evidence of a spawning run up the Sled River. The Sled River was examined for evidence of walleye spawning by the local conservation officers (Zimmer pers. comm.[1]) in the spring of 1987. None were seen or recovered in a test net placed in the mouth of the river. Examination of the physical features of the lower reach of the river by laboratory staff showed about 850 m of adequate spawning habitat with respect to substrate and water current. Old beaver dams which had posed as potential obstructions for spawning fish were removed in the late winter of 1986. The conclusions to be drawn are that the spawning walleye population was too small to be detected in the cursory observations made in 1987 or that spawning occurs in the shallow areas of the lake itself since no other streams are known to provide suitable spawning habitat for this species.

Suckers of both species are known to use the Sled River for spawning. Specimens in spawning condition were caught in test nets in the mouth of the river in the spring of 1987 (Zimmer pers. comm.[1]).

1. W. Zimmer - Conservation Officer, Dore Lake

Northern pike are abundant in Bazill Bay shortly after spring breakup suggesting that spawning takes place in the shallow weedy areas in this part of the lake. Pike have been known to ascend the Sled River through Sled Lake and into Beaupre Creek to spawn. According to local sources, the spawning run into Beaupre Creek is presently blocked by beaver dams.

Bazill Bay is also recognized as a major spawning area for lake whitefish which migrate to this part of the lake in the fall. The spawning run has frequently been used by commercial fishermen to provide easy access to large numbers of whitefish.

Bazill Bay is closed to commercial fishing in the period from the closure of the winter fishery to the end of May. This special closure was put in place to protect spawning walleye and pike populations. It is recommended that the closure be extended to include angling during this period. Protection of the spawning whitefish population in the bay will be possible without a special closure if the recommended elimination of the fall fishery is enacted.

5. DISCUSSION

5.1 FISH POPULATIONS

The provision of all-weather road access to Dore Lake in 1956 has brought with it increased fishing pressure from anglers and commercial fishermen and with it an increased awareness of changes in populations of various fish species. Two earlier studies (Ruggles 1959a; Johnson 1968) were undertaken to investigate causes for reported declines in walleye populations. A smaller fish stock assessment

completed in 1983 (Walton 1983) sought to explain decreased harvests of lake whitefish and northern pike. The present study was undertaken in response to persistent claims of poor walleye fishing and harvests of small whitefish.

Fish populations in many lakes appear to undergo cyclic changes unrelated to external influences such as angling and commercial fishing (eg. lake trout and whitefish populations in Lac la Plonge) (Sawchyn 1986). In other lakes changes in species composition and numbers are in direct response to fishing pressure. Examples of the latter have been demonstrated for Last Mountain, and Jackfish Lakes (Liaw 1978, 1979; Durbin 1980), and Peter Pond and Turner Lakes (Kallemeyn 1973, 1974) where changes in fish management strategies have resulted in direct changes in fish populations.

The present study of the fishery in Dore Lake has sought to uncover explanations for changes in fish populations and to provide measures which would mitigate some of the less desirable trends.

Several major changes in fish species proportions have taken place in Dore Lake in the past 20 years. A continuing decline in walleye stocks has been prevalent throughout the period with a potential for elimination of the species from the lake within five years if the trend cannot be reversed. Paralleling this decline has been an increase in both common and longnose suckers. Whitefish and pike have both experienced serious population reductions and rapid recoveries in this period. Perch whose population appears to have peaked in the 1970s continue to be present in high numbers.

In a fishery where commercial fishermen, anglers and mink ranchers are competing for a common resource it is not uncommon for one user group to hold another responsible for changes in fish populations. Johnson (1968) addressed the issue of conflicting resource users on Dore Lake. He noted that each fishery is concentrated in a specific area of the lake. Most of the commercial fishing is done in Bazill Bay and the northern island areas whereas the sport fishery is most concentrated in South Bay and around Michel Point because these are the points of road access. The mink ranchers at the time lived at South Bay and did most of their fishing between Michel Point and the northeast point of Bazill Bay. He suggested that if the decrease in walleye and pike could be attributed to fishing, which he felt doubtful, then no one fishery could be blamed since the population decrease was uniform over the entire lake. He suggested that some unknown but powerful factor has interfered with reproduction in at least four successive years followed by intermittent reproductive success since then.

Our interpretation of the data supports Johnson's to a point, that is, that no one fishery should be held responsible for the walleye population decline. The decline occurred in a period of intense commercial fishing pressure, the opening of the lake to anglers and the development of a large mink ranch fishery with permitted use of small mesh gill nets. The heavy fishing pressure on both pike and walleye reduced stocks of mature old fish and allowed competing fish species such as suckers and perch to increase. The latter provided an abundance of food for both pike and walleye which explain the very rapid growth presently being experienced by these fish. In the case

of walleye, growth is so rapid that fish become vulnerable to angling and gillnetting before they have had an opportunity to achieve their reproductive potential. The present disproportionately high population of perch distributed throughout the lake provided direct competition for food and space for young walleye as well as potentially severe predation on young walleye themselves.

The large populations of suckers are providing direct competition for lake whitefish food resources. By using Bazill Bay and the Sled River for spawning, suckers may be feeding on eggs of whitefish spawned in this same area the previous fall.

The proposed strategy for management of the fishery resources of Dore Lake centers on two factors:

1) To reduce the numbers of competing fish species, namely suckers and perch;
2) To provide better opportunities for the growth and development of gamefish species in achieving reproductive age and spawning.

Since there is presently no market for suckers and small perch, the control of these species must be achieved through natural predation. Allowing stocks of pike and walleye to increase will tip the population imbalance in favor of game fish species. To accomplish this, restrictions must be placed on the harvest of both species. It is recommended that separate species quotas be introduced for the commercial fishery on pike and walleye. Annual quotas of 20 000 kg for pike, and 4 000 kg quota for walleye are recommended. The harvest of walleye by anglers should be limited to three fish per day. Further protection of the spawning areas of both species is necessary. In 1979 the Dore Lake fishermen decided that commercial fishing should be banned in

Bazill Bay during the spawning period. The ban appeared in the Saskatchewan Gazette in 1982 and remains in effect at the present time. The ban imposed for the period from April 16 to May 31, inclusive, covers the area defined in Fig. 24. We propose that the fishing ban be expanded to include angling as well as commercial fishing.

Walleye are known to concentrate in shallow feeding areas in the northeast part of Dore Lake in late August as water temperatures cool. The majority of walleye presently caught commercially in Dore Lake are taken in this area over a 2-3 week period. In order that the species be protected we suggest that the fall commercial fishery be discontinued from August 15 until freezeup. This recommendation will also protect spawning whitefish which are known to concentrate in Bazill Bay in the fall. Since the whitefish population appeared to be thriving at the time of this study no other protective measures for this species appear to be necessary.

5.2 FISH SPAWNING

Although the study concentrated on fish species, growth rates and habits relative to the earlier studies, two physical factors which might affect walleye and pike populations were recognized. Durbin (1980) correlated high reproductive success of pike in Jackfish Lake with high water levels. Walton (1983) tried to relate pike populations with water levels in Dore Lake based on discharge rates via the Dore River but was unable to draw any specific conclusions. He suggested that should there be a relationship between water level and spawning success of pike then the lower than average discharges since May of

Fig. 24 Dore Lake, showing the portion of Bazill Bay banned to commercial fishing during spring spawning.

1980 could be related to the poor reproductive success of pike in that period. The present study noted water levels comparable with those reported in 1965 (Johnson 1968). These are supported by data from the Saskatchewan Water Corporation (Environment Canada 1987, microfilmed data) which show very stable water levels in Dore Lake since 1971 (Table 17). Similarly, mean monthly discharge data in the Dore River, provided by Environment Canada (1987) (Table 18) show no trend in spring discharges which may be related to success or lack of success in pike spawning. Should pike population declines occur again in the future their relationship to water levels and Dore River discharge should be reassessed.

Bazill Bay has for many years been recognized as an area where pike and walleye congregate in spring leading to speculation that the Sled River may be a major migration route and spawning area for these species. Major spawning runs of these species in the Sled River have never been documented. Blockage of the river by beaver dams was believed to be a possible cause for lack of walleye recruitment. The obstructions were cleared in March of 1985. Examination of the channel in May, 1987, showed adequate walleye spawning riffles in the lower reach of the river suggesting that the obstructions probably did not interfere with walleye spawning. No walleye eggs or fry were found in the riffle areas. Local fishermen have identified Beaupre Creek as a significant migration route for pike. In the event that pike leave Dore Lake to spawn in Sled and Beaupre Lakes both the Sled River and Beaupre Creek should be maintained free of obstructions.

Table 17. Mean relative water levels (m)[1] in Dore Lake.

	April	May	June	July	August	Sept.
1965	-	-	-	28.406	28.416	-
1966	-	-	-	28.412	28.410	-
1967	-	-	-	28.264	28.253	28.149
1968	-	-	28.129	28.121	28.083	28.079
1969	-	-	28.114	28.088	28.150	-
1970	-	-	28.261	28.423	28.453	28.413
1971	-	28.433	28.562	28.583	28.573	-
1972	-	-	-	-	-	-
1973	-	-	28.594	-	-	-
1974	-	-	-	29.067	-	-
1975	-	-	28.814	28.896	-	-
1976	-	-	28.678	-	-	-
1977	-	-	28.554	-	-	-
1978	-	-	28.528	28.516	28.508	-
1979	-	-	28.505	28.582	28.562	-
1980	-	28.419	28.421	28.431	28.440	-
1981	-	-	28.543	28.545	28.517	-
1982	-	-	28.411	28.412	28.411	-
1983*	-	-	28.388	-	-	-
1984*	-	-	28.444	-	-	-
1985	-	-	-	-	-	-
1986*	-	-	28.437	28.481	28.560	-
1987	-	-	-	-	-	-

1. Data from Sask. Water Corporation and Environment Canada.

* Based on incomplete data.

Table 18. Mean monthly discharges (m^3/s)[1] from Dore River near mouth.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1971						8.15	6.68	3.29	2.07	2.19	0.74	0.92
1972	0.74	1.01	2.64	3.81	13.90	6.05	5.13	2.45	4.95	6.55	5.20	1.25
1973	2.51	4.79	5.20	7.31	9.67	8.07	9.32	5.06	7.28	7.57	7.75	5.57
1974	5.94	5.97	4.56	5.25	16.50	14.60	8.46	5.76	7.31	8.28	8.79	8.80
1975	8.30	7.11	6.48	7.35	15.90	21.70	12.10	11.70	8.74	8.47	7.66	6.99
1976	3.96	4.69	6.11	7.71	9.75	8.85	7.34	3.08	2.04	2.29	1.51	1.06
1977	-	-	-	-	-	-	-	-	-	1.56	-	-
1978	0.78	0.84	-	-	-	-	1.99	1.81	2.27	2.49	1.84	1.21
1979	1.40	1.44	1.46	4.16	9.37	7.72	4.74	2.24	3.53	3.20	2.54	1.79
1980	0.98	1.38	1.88	3.91	5.04	2.08	1.49	4.01	11.60	6.29	3.37	2.22
1981	1.83	1.42	2.22	6.51	8.30	5.54	2 49	1.53	0.98	0.96	0.98	0.85
1982	0.61	0.57	0.59	2.38	7.98	5.87	2.39	1.94	1.26	2.77	1.85	0.93
1983	1.02	1.13	1.14	2.63	6.50	5.06	4.04	1.48	2.07	1.80	1.34	0.71
1984	0.58	0.66	0.98	3.52	10.00	6.78	2.08	0.99	0.90	1.15	0.64	0.60
1985	0.47	0.52	0.80	5.23	9.09	8.93	2.38	1.25	1.58	1.63	0.73	0.41
1986	0.41	0.42	0.99	2.93	7.99	6.07	7.00	6.87	2.58	2.18	1.43	1.25

1. Data from Environment Canada.

5.3 PREDATION BY BIRDS

In the years of declining game fish populations, commercial fishermen and outfitters noted a parallel and somewhat dramatic increase in double-crested cormorants. Since cormorants are fish-eating birds fishermen groups have become convinced that they are responsible for the decline in sport fish species. Recent increases in pelican populations will bring similar concerns. Barber (1983) of the Saskatchewan Wildlife Branch undertook a review of information on cormorant and pelican populations relative to the Dore Lake fishery. The population of cormorants increased from an estimated 50 to 75 birds in 1977 to approximately 9500 in late summer of 1983. The cormorants occupy 3 islands as nesting sites - 2 in Bazill Bay and one in East Bay. Two of the three islands are designated as wildlife refuges for the purpose of protecting white pelicans and Caspian terns. A breeding colony of Caspian terns, located on Rock Island is the only one in Saskatchewan. Pelicans were, until 1987, considered a "threatened" species in Canada according to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). In 1983 Saskatchewan Wildlife Act regulations were implemented prohibiting access to Saskatchewan pelican colonies between April 15 and September 15. Under these regulations both the island in Bazill Bay occupied by a pelican colony and Rock Island are protected by a 100 m buffer zone in which boat traffic is prohibited. Although cormorants are not protected by either the Migratory Bird Convention Act or the Saskatchewan Wildlife Act their nesting areas on two of the three islands in Dore Lake are shared by protected species.

Literature indicates that cormorants are opportunistic feeders, primarily taking fish whose abundance and behaviour make them most available (Barber 1983). Preliminary indications are that cormorants are feeding primarily on suckers and yellow perch (B. Hanbidge pers. comm.[1]), although the presence of game fish species in regurgitated stomach contents has been observed (Edquist pers. comm.[2]). A detailed report on the biology of cormorants on Dore Lake is being prepared by Hanbidge as part of a thesis project for the University of Saskatchewan, Department of Biology. Cormorants require about 0.45 kg (1 lb) of food per day (Barber 1983). Based on this requirement Dore Lake cormorants could have removed 350 000 kg (770 000 lb) in 1982 and as much as 475 000 kg (1 047 000 lb) of fish in 1983.

Pelicans were absent from Dore Lake for a 10 year period from 1972 to 1982. In 1982 about 200 adults returned to the lake and have established a nesting colony on an island west of Smith Island in Bazill Bay. Pelicans are also opportunistic birds and consume substantial quantities of fish. The pelicans congregate in large numbers on the Sled River in the spring and are undoubtedly feeding on spawning fish. Because of their late arrival, the species most affected would be walleye and suckers. Since white pelicans are protected under existing wildlife legislation no action can be taken against this species.

The opportunistic feeding habits of both species of fish-eating birds would suggest that they feed primarily on suckers and perch and have increased in numbers in direct response to the increased food

1. B. Hanbidge - Graduate Student, Department of Biology, Univeristy of Saskatchewan

2. F. Edquist - Conservation Officer, Dore Lake

supply provided by these rough fish species. Through this feeding behaviour the cormorants and pelicans are performing a beneficial function in controlling and eventually reducing the rough fish population in Dore Lake. The birds are expected to decline in numbers or disperse to other lakes with diminishing food supplies.

5.4 LAKE PRODUCTIVITY

Walton (1983) in his fisheries status report on Dore Lake undertook a detailed assessment of the production potential of commercial species relative to actual harvest. Using Ryder's morpho-edaphic index (MEI) as his basic assessment tool (Ryder 1965) he determined that Dore Lake with an MEI of 17.4 should have a yield potential of all commercial species of 5.07 kg/ha/yr. To derive estimates by species, ie. whitefish, pike and walleye, a procedure described by Colby (1982) was applied.

Commercial production data from 42 years of record, fur farm fishing harvests for 11 years, angling data from outfitter lodges for 5 years and harvest estimates from cottage anglers were used to provide average species yields for comparison with the potential yield as derived from the MEI. The result was a total species yield of whitefish, pike and walleye of 5.75 kg/ha/yr or 113.4% of the MEI estimate.

Whitefish represented 70% of the potential yield, far in excess of the guideline level of 24% derived by the method of Colby (1982). Walton noted that historically Dore Lake has been able to sustain whitefish production at this high level and there is no reason to suggest that the limit should be lowered.

The guideline levels for pike were 25% of potential yield for a fishery such as Dore Lake. The actual value derived for Dore Lake by this method was 24%. This translates to a maximum sustainable yield of 81 400 kg (179 500 lb) of pike. In years of reduced angling success, the commercial harvest approached 45 500 kg and the average fur farm harvest was about 15 000 kg. The remainder would have been taken by angling.

Walton noted that walleye harvests as recommended by the guidelines depend on the nature of the fishery. The guidelines for a sport fishery, commercial fishery or combined sport/commercial fishery were 10 to 20%, 25% and 25%, respectively. This suggests that walleye could be produced at a level of 65 100 kg (143 000 lb) based on commercial harvests. Had walleye harvests been a product of both angling and commercial fishing or angling only, the recommended guideline would be 32% of the MEI productivity or a walleye production level approaching 104 200 kg (229 700 lb). While Dore lake has produced this amount of walleye in 8 out of 42 years of commercial harvesting, Walton suggested that this appears to be significantly above the sustainable yield and that maximum sustainable harvest should be in the area of 68 000 to 82 000 kg (150 000-180 000 lb). In a period of virtual collapse of the walleye fishery even the reduced estimate is totally unrealistic.

The results of this study support Walton's conclusion that the whitefish quota on Dore Lake should remain relatively high. The proportion of pike harvested by commercial fishermen combined with angling harvests and fur farm fishing provide a level of production approaching the estimated sustained yield. A separate species limit

for pike of 20 000 kg has been recommended. This value is consistent with long term commercial harvest trends and is similar to the harvest recommended by the Dore Lake Allocation Committee. Until substantial recovery of the walleye population has occurred there is no hope of approaching the calculated sustained yield for this species. Our recommendations therefore provide for a minimum separate quota of 4 000 kg for walleye in the commercial fishery which will still allow other species to be harvested. A reduction in angling quotas to three walleye per day is being recommended to provide this species with added opportunity to recover. The fish populations should be reassessed in five years or less to determine whether the population structure has changed. Upward adjustment of commercial and angling quotas should be made for walleye when the population has recovered sufficiently to provid adequate reproductive stocks and evidence of successful recruitment.

In the establishment of separate quotas for pike and walleye it is recommended that the total commercial quota for Dore Lake remain unchanged at 272 100 kg (600 000 lb). A pike quota of 20 000 kg (44 000 lb) and a walleye quota of 4 000 kg (8 820 lb) should be subtracted from this amount to provide a whitefish quota of 248 100 kg (547 000 lb). The lake should be closed to all commercial fishing if any one of these quotas is exceeded. A method for distribution of the various quotas among the commercial fishermen should be developed by the local fishermen's co-operatives.

Estimates of potential production of common and longnose suckers (combined) were derived relative to whitefish harvests based on proportions of these species caught in the 12.7 cm mesh of the standard

gillnet catches. Thirty-nine sets yielded 150.7 kg of suckers in the 12.7 cm mesh (the legal mesh size for the commercial fishery) as compared with 45.3 kg of whitefish. A harvest of 240 000 kg of whitefish per year would suggest that up to 745 960 kg of suckers are being harvested and discarded. A similar calculation using the 10.2 cm mesh provides an estimated sucker yield of 1 430 000 kg per year. In view of the high sucker populations in Dore Lake a conservative production estimate for Dore Lake could range from 750 000 to 1 000 000 kg per year. Lack of suitable markets and low prices for suckers make it unlikely that the sucker resource will be utilized in the near future.

6. SUMMARY AND CONCLUSIONS

1) A detailed fisheries survey of Dore Lake was undertaken in the summer of 1986 to evaluate the issue of declining walleye stocks. The study was patterned after two earlier studies undertaken in 1956 and 1965.
2) Dore Lake, located 193 km northwest of Prince Albert, has been provided with road accessible angling since 1956, a commercial fishery since 1911, and mink ranching since 1940.
3) The fisheries resource presently supports 23 active commercial fishermen, clientele from 3 outfitters' lodges, numerous cottage and day anglers, and one mink ranch.
4) Dore Lake is situated on boreal glacial deposits. It has an area of 616 km^2 (152 160 acres), a maximum depth of 20.4 m and a mean depth of 11 m. Dore Lake is considered a headwater lake with the Sled River as the only significant inflowing stream. Discharge is by way of the Dore River to the Beaver River and Ile-a-la-Crosse.

5) Dore Lake is too shallow to provide stable thermal stratification. Peak summer temperatures reach 18°C. Some depletion of bottom dissolved oxygen occurs over a large area in the northern part of the lake.

6) Chlorophyll levels in Dore Lake border on the upper margin of levels typical of lakes in forested areas but are considerably lower than those found in lakes in mixed-wooded cultivated areas. Plankton standing crop ranged from 11.6 kg/ha in the spring to 61.4 kg/ha at the height of the growing season.

7) Midge larvae (Chironomidae) were the predominant benthic organisms in Dore Lake. Amphipods, sphaeriid clams and oligochaetes made up less significant proportions. Total numbers of bottom fauna were one-fifth of the numbers reported in 1965. Standing crop at 22.4 kg/ha was approximately one-half that reported in 1956 and 1965. Most severe reductions were in numbers of sphaeriids, a principal component of whitefish diets.

8) Our study reported 15 species of fish in Dore Lake. Two species found in earlier studies, longnose dace and large ciscoes, were not present.

9) Yellow perch were the dominant species caught in seine nets and minnow traps. Next in order of abundance were emerald shiners and fathead minnows. The latter two species appear to have replaced spottail shiners which were the most numerous in 1956.

10) Numbers of sucker fingerlings are low suggesting a possible trend toward a decline in the sucker populations. Brook sticklebacks have increased from one specimen in 1965 to 12.4% of the trapnet catches.

11) Thirty-nine standard gillnet sets yielded a total of 5924 fish. White suckers were the most abundant at 41.6% followed by perch at 32.6%. Fish species of no current economic value made up 85.2% of the catch by numbers and 69.8% by weight. Walleye made up 0.8% of the catch, pike 3.9% and whitefish 10.0% by numbers.

12) Numbers and weight of lake whitefish were about 50% higher than they were in previous studies. Northern pike, which declined drastically between 1956 and 1965, are showing a modest recovery from being seriously depleted once again in the early 1980s. They are now the most abundant sport fish in Dore Lake.

13) Walleye, which showed a serious decline in numbers between 1956 and 1965, continue to decline to the point where only 51 fish averaging 1.3 per net set were caught during the entire summer in 1986.

14) The population of white suckers has more than doubled in the last 20 years. Longnose sucker populations have increased. Yellow perch, which are still very abundant (32.6%) in Dore Lake, have undergone a reduction from an average of 183.8 per net set in 1965 to 49.4 per set in 1986.

15) The majority of northern pike caught were more than 50 cm long and weighed more than 1 kg. Eighty percent of the specimens were in the two and three year age classes showing rapid recovery of pike populations is possible under favorable spawning conditions. Pike growth is relatively constant with age, averaging 0.5 kg/yr. Pike were consistently larger at any given age in 1986 than in 1965 showing improved conditions for growth. Sexual maturity occurs in the third season of growth. Perch and sticklebacks are the most common food of pike.

16) Most of the 51 walleye caught were larger than 30 cm ranging from 3 to 5 years showing very low recruitment but very rapid growth rate. Walleye now take 3 to 5 years less time to achieve catchable size than the sample taken in 1956. The oldest walleye caught were 7 years. In 1956 21% of walleye were older than 7 years; in 1965 7% exceeded 7 years. Sixty-five percent of walleye caught were immature. All of the walleye caught in the 12.7 mesh size (the legal commercial net size) would have been mature. Ciscoes and suckers are most commonly consumed by walleye.

17) A strong population of whitefish ranging in size from 30 to 42 cm is present in Dore Lake. A smaller peak of young fish indicates good reproductive success. Whitefish in Dore Lake ranged from 1 to 12 years with the bulk of the harvestable population being 5 to 6 years old. Lack of significant numbers of older fish suggests recruitment failure for several years in succession prior to 1981-82, heavy fishing pressure or a combination of both. Whitefish mature in 5-6 years at which time they are 34 (males) to 36 (females) cm long. The commercial nets harvest fish upwards of 33 cm with the majority 36 cm long.

18) No detailed analyses were carried out on the other fish species (ie. perch, suckers, burbot and ciscoes).

19) Twenty-three active commercial fishermen participate in the Dore Lake commercial fishery. Commercial fish production is presently limited to 272 100 kg including pike, walleye and whitefish. The quota is divided between a summer fishery (181 400 kg) and a winter fishery (90 700 kg). A mesh size of 12.7 cm is presently in effect.

20) Lake whitefish generally make up in excess of 75% of the catch. In the last four years walleye production has been less than 10 000 kg/yr. Pike harvest has been voluntarily held to 18 000 kg by the local Allocation Committee.

21) Only one mink ranch remains on Dore Lake. This ranch utilizes about 45 000 kg of fish, 88% of which are suckers and burbot. Smaller mesh nets (11.4 cm) are still permitted in the harvest of mink food.

22) Two outfitters were in operation on Dore Lake in 1986. A third lodge reopened in the spring of 1987. Few creel census data or records of sportfish catches by clients of the lodges are available. Anglers rely almost entirely on northern pike. Of 721 fish carcasses examined at fish filletting stations at the lodges, only 20 were walleye. Thirty-seven of 214 fish examined at the public campsites were walleye. The majority of the latter were smaller than 40 cm and probably immature.

23) The study concluded that fishing pressure and reproductive failure have created a severe imbalance in the Dore Lake fish population resulting in the virtual elimination of the walleye stocks, and a buildup of rough fish species. Rapid growth rate of remaining walleye is causing them to become vulnerable to angling and gillnetting before they are able to express their reproductive potential.

24) Large populations of cormorants do not appear to be feeding extensively on gamefish species in Dore Lake.

25) Perch may be competing with walleye for food resources and may be preying on walleye fry and fingerlings. Similarly, suckers are competing for food resources of whitefish.

26) Beaver dams cleared from the Sled River probably did not interfere with walleye spawning since suitable sites are found downstream of their locations. The dams probably interrupted pike spawning migrations into and through Sled Lake.

7. SUMMARY OF RECOMMENDATIONS

1) It is recommended that the total commercial fishery quota remained unchanged at 272 100 kg, however, separate species quotas should be established to protect the sport fish species. The total quota should be apportioned as follows: 4 000 kg for walleye, 20 000 kg for northern pike and 248 100 for lake whitefish. Lake closure should take effect when any of the three quotas have been reached.

2) Apportionment of the individual quotas among the fishermen should remain the responsibility of the local fishermens' co-operatives.

3) The summer commercial fishery on Dore Lake should be closed August 15 to protect walleye concentrations in the northeast part of the lake and the late autumn whitefish spawning run in Bazill Bay.

4) The spring closure of Bazill Bay to commercial fishermen in the period from breakup to May 31 should be extended to include anglers.

5) A special limit of 3 walleye should be placed on daily catches by anglers.

6) The restrictions on commercial fishing and angling for walleye should be reassessed in 5 years relative to changes in walleye populations.

7) Spawning areas for walleye and pike from Dore Lake should be maintained free of obstructions.

8) No new developments should be undertaken on Dore Lake which will place added pressure on the sport and commercial fish species presently being utilized.

9) The current fur farm fishery should be allowed to continue so long as it harvests about 90% suckers and burbot. However, no new fur farm fishing licenses should be permitted on the lake. The purchase of suckers and burbot from commercial fishermen should be encouraged.

8. LITERATURE CITED

Barber, S. 1983. Cormorants and pelicans in relation to the Dore Lake fishery. Tech. Paper, Wildl. Br., Sask. Parks and Renewable Resources.

Colby, P. T. (Chairman). 1982. Partitioning yields estimated from the morphoedaphic index into individual species yields. Rept. of Strategic Planning for Ontario Fisheries, Working Group No. 12.

Durbin, J. K. 1980. Gamefish populations under impact, Jackfish - Murray Lakes. Fisheries Tech. Rept. 80-6, Sask. Tourism and Renewable Resources, 139 pp.

Environment Canada. 1987. Surface water data, Saskatchewan, 1986. Inland Waters Directorate, Water Resources Branch, Water Survey of Canada, Ottawa.

Johnson, R. P. 1968. Changes in the fishery of Dore Lake between 1956 and 1967. Fisheries Tech. Rept. Sask. Dept. Nat. Res. 136 pp.

Kallemeyn, L. W. 1973. Peter Pond and Churchill Lakes, 1973. Fisheries Tech. Rept. 73-3, Sask. Dept. Nat. Res., 146 pp.

Kallemeyn, L. W. 1974. Turnor and Wasekamio Lakes. Fisheries Tech. Rept. 73-4. Sask. Dept. Nat. Res. 79 pp.

Liaw, W. K. 1978. Jackfish and Murray Lakes, environmental changes and whitefish populations. Fisheries Tech. Rept. 78-5, Sask. Tourism and Renewable Resources. 97 pp.

Liaw, W. K. 1979. Whitefish fisheries in Saskatchewan. Fisheries

Tech. Rept. 79-4, Sask. Tourism and Renewable Resources. 45 pp.

Liaw, W. K. 1982. Water quality in recreational lakes, Saskatchewan. In: Wastes and Prairie Water Quality, Water Studies Institute Symp. 8.

Lorenzen, C. J. 1967. Determination of chlorophyll and pheopigments: spectrophotometric equations. Limnol. and Oceanogr. 12:343-346.

Mendis, A. S. 1956. A limnological comparison of four lakes in central Saskatchewan. Fish. Br. Sask. Dept. Nat. Res. 2:23.

Prince, E. E., T. H. McGuire, and E. Sisley. 1912. Dominion Alberta and Saskatchewan Fisheries Commission, 1910-1911. Part II. Ottawa Gov't. Print. Bur. 152 pp.

Rawson, D. S. 1960. A limnological comparison of twelve large lakes in northern Saskatchewan. Limnol. Oceanogr. 5(2):195-211.

Ruggles, C. P. 1959a. Biological and fisheries survey of Dore Lake, 1956. Fisheries Tech. Rept., Sask. Dept. Nat. Res., 44 pp.

Ruggles, C. P. 1959b. Biological and fisheries survey of Lac la Plonge and Canoe Lake. Fisheries Tech. Rept., Sask. Dept. Nat. Res., 91 pp.

Ryder, R. A. 1965. A method for estimating the potential fish production of north - temperate lakes. Trans. Amer. Fish. Soc. 94(3):214-218.

Sawchyn, W. W. 1986. Evaluation of lake trout and lake whitefish resources in Lac la Plonge. Fisheries Tech. Rept. 87-1, Sask. Parks Rec. and Cult., 65 pp.

Walton, D. 1983. Dore Lake fisheries status, 1983. Tech. Rept. to Dept. Northern Sask.

9. APPENDICES

Appendix I Gillnet summary, Dore Lake, 1986.

	Pike		Walleye		Whitefish		White Sucker		Longnose Sucker		Burbot		Perch		Cisco	
	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)
Net Set 1	29	46.3	0	0.0	41	32.8	92	67.4	13	18.8	0	0	20	0.7	0	0.0
2	3	7.7	3	2.5	15	4.8	163	134.0	11	11.4	6	11.9	47	4.1	0	0.0
3	2	3.7	1	.4	9	5.1	47	24.7	3	2.0	15	31.8	25	2.7	0	0.0
4	5	5.2	0	0.0	2	1.1	75	60.0	3	3.3	1	2.6	1	0.1	1	0.0
5	0	0.0	2	0.9	8	4.4	6	5.0	1	.4	10	17.1	1	0.0	2	0.1
6	2	1.3	4	3.5	4	2.1	60	41.2	4	4.1	13	22.0	53	3.3	0	0.0
7	1	1.8	1	1.1	10	8.9	53	31.2	16	19.8	0	0.0	0	0.0	1	0.1
8	3	5.6	0	0.0	9	5.1	29	17.8	3	4.3	1	2.9	2	0.1	0	0.0
9	0	0.0	1	1.4	2	1.1	44	18.0	1	.9	1	1.4	62	3.1	2	0.1
10	0	0.0	0	0.0	73	46.1	46	22.4	19	16.4	4	4.8	4	0.1	0	0.0
11	1	1.3	1	0.7	4	2.6	39	17.5	0	0.0	8	18.0	41	2.0	3	0.2
12	3	8.1	0	0.0	36	32.3	24	15.6	7	9.9	0	0.0	0	0.0	1	0.1
13	1	2.6	1	0.6	31	13.3	50	20.5	2	2.1	0	0.0	18	.7	9	0.5
14	56	94.8	4	3.5	6	6.1	53	40.7	0	0.0	1	2.0	0	0.0	0	0.0
15	1	3.3	0	0.0	1	.1	68	15.4	14	5.3	0	0.0	98	6.3	12	0.6
16	1	2.3	0	0.0	2	.3	23	11.2	19	10.1	1	1.1	185	11.3	2	0.1
17	41	77.1	2	1.7	0	0.0	20	19.2	0	0.0	0	0.0	30	1.2	0	0.0
18	15	28.1	0	0.0	15	8.8	80	72.2	0	0.0	0	0.0	1	0.0	0	0.0
19	1	2.4	1	0.1	2	1.0	103	26.7	24	6.6	0	0.0	104	5.5	29	1.4
20	8	14.7	0	0.0	8	2.7	54	48.0	0	0.0	0	0.0	7	1.5	3	0.1
21	0	0.0	0	0.0	33	15.5	5	2.6	6	5.4	0	0.0	17	0.7	52	2.3
22	1	2.0	0	0.0	4	0.4	90	40.1	8	8.3	0	0.0	15	1.1	4	0.3

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	Pike		Walleye		Whitefish		White Sucker		Longnose Sucker		Burbot		Perch		Cisco	
	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)
Net Set 23	0	0.0	0	0	12	1.0	73	26.9	3	1.5	0	0.0	2	0.1	18	0.8
24	7	18.7	6	6.8	6	0.6	74	65.4	8	8.1	1	3.2	1	0.0	6	0.3
25	2	4.6	3	2.5	31	7.7	100	68.8	0	0.0	0	0.0	0	0.0	0	0.0
26	29	43.4	5	6.2	2	2.3	126	82.1	0	0.0	0	0.0	77	4.0	0	0.0
27	0	0.0	0	0.0	9	2.6	82	31.2	28	18.6	2	3.7	4	0.2	22	0.9
28	9	24.7	6	10.7	2	1.0	29	24.9	2	2.6	0	0.0	7	0.6	0	0.0
29	8	24.6	1	1.6	2	2.7	98	59.4	0	0.0	0	0.0	8	0.4	3	0.1
30	2	4.6	2	.1	7	6.5	80	51.3	1	1.8	0	0.0	210	7.1	7	0.4
31	0	0.0	0	0.0	10	2.4	6	0.6	7	6.1	0	0.0	30	1.1	18	0.8
32	0	0.0	6	4.0	4	1.3	83	36.8	2	2.8	0	0.0	107	5.0	18	0.8
33	0	0.0	0	0.0	17	6.1	30	19.4	6	4.5	1	1.2	49	2.3	24	1.1
34	0	0.0	0	0.0	3	0.3	153	24.9	2	1.1	1	1.9	13	0.7	6	1.3
35	0	0.0	0	0.0	19	5.6	99	35.2	5	3.7	2	4.4	406	25.8	27	1.2
36	0	0.0	0	0.0	13	3.2	132	55.3	5	6.8	3	3.6	165	7.0	8	0.5
37	0	0.0	0	0.0	104	59.9	2	0.7	1	0.4	0	0.0	12	0.9	6	0.3
38	1	1.3	1	0.1	11	6.4	50	25.6	3	3.2	1	1.1	29	1.8	16	0.5
39	0	0.0	0	0.0	26	11.3	23	10.5	20	13.8	2	4.6	76	4.0	35	1.5
Total	232	429.9	51	48.3	593	315.4	2465	1370.1	247	203.7	74	139.1	1927	105.3	335	16.0
Average/set	5.9	11.0	1.3	1.2	15.2	8.1	63.2	35.1	6.3	5.2	1.9	3.6	49.4	2.7	8.6	0.4
Percent of total	3.9	16.4	0.8	1.8	10.0	12.0	41.6	52.1	4.2	7.7	1.2	5.3	32.6	4.0	5.7	0.6

APPENDIX II Fish catch distribution in various mesh sizes of gillnets used in Dore Lake 1986, (39 standard gangs).

Mesh Size, cm	Number							Weight, (Kg)						
	3.8	5.1	7.6	10.2	12.7	14.0	Total	3.8	5.1	7.6	10.2	12.7	14.0	Total
Northern Pike	31	46	99	43	9	4	232	51.2	68.5	172.7	89.9	29.7	17.9	429.9
Walleye	8	5	18	11	9	-	51	3.6	4.5	14.2	11.4	14.6	-	48.3
Lake Whitefish	82	141	159	162	42	7	593	18.8	35.3	87.0	119.9	45.3	9.1	315.4
Common White Sucker	473	359	847	706	67	13	2465	44.2	89.3	467.5	646.7	100.0	22.5	1370.2
Longnose Sucker	9	47	69	73	36	13	247	2.0	21.0	45.6	63.7	50.7	20.7	203.7
Burbot	4	6	5	19	25	15	74	9.7	15.4	7.9	24.8	45.2	36.3	139.3
Yellow Perch	1588	331	6	2	-	-	1927	72.9	32.1	0.2	0.10	-	-	105.3
Cisco	319	12	2	1	-	-	335	15.5	0.4	0.1	0.03	-	0.01	16.0
TOTAL	2514	947	1205	1017	188	53	5924	217.9	266.5	795.2	956.5	285.5	106.5	2628.1

Appendix III Commercial fish production (kg) record for Dore Lake.

Year	Whitefish	Walleye	Pike	Others	Total	No. of Licenses
1920-21	397,535	24,585	53,253	40,189	515,562	70
1921-22	268,123	12,701	22,998	50,985	354,806	62
1922-23	215,732	22,816	41,640	79,017	359,206	73
1923-24	275,743	44,362	47,447	78,745	446,297	77
1924-25	244,989	29,439	27,080	76,704	378,212	63
1925-26	181,984	26,626	38,692	52,708	300,011	-
1926-27	270,581	12,884	26,632	37,500	346,907	57
1927-28	158,125	21,319	27,216	[illegible],748	240,408	58
1928-29	188,017	42,139	40,643	21,092	291,892	77
1929-30	121,383	45,768	24,494	12,565	204,210	57
1930-31	140,616	29,484	33,476	14,742	218,318	42
1931-32	213,963	17,237	19,323	5,443	255,966	51
1932-33	213,978	17,237	19,323	5,443	255,981	51
1933-34	225,741	15,170	16,028	16,294	273,233	38
1934-35	280,943	36,139	31,425	23,636	372,143	55
1935-36	204,420	41,080	24,517	14,217	284,234	70
1936-37	183,802	71,061	59,680	24,517	339,059	72
1937-38	161,865	43,802	60,921	47,188	313,776	69
1938-39	132,875	51,758	51,496	29,623	265,753	69
1939-40	205,854	43,863	31,143	21,675	302,534	63
1940-41	203,987	52,330	39,655	16,411	312,382	73
1941-42	184,388	118,533	66,125	21,259	390,305	77
1942-43	280,162	145,791	89,604	22,682	538,239	91
1943-44	243,168	153,304	108,402	51,906	556,780	108
1944-45	154,801	96,793	89,494	17,429	358,517	106
1945-46	208,474	129,260	79,532	27,664	444,930	75
1946-47	120,772	120,714	22,677	15,968	280,131	32
1947-48	224,077	42,855	73,606	12,083	352,621	55
1948-49	203,174	51,119	69,645	26,744	350,682	60
1949-50	207,962	66,443	68,241	29,110	371,756	68
1950-51	243,456	36,084	17,953	10,808	308,301	69
1951-52	274,310	33,816	23,579	17,782	349,487	91
1952-53	304,539	56,338	24,975	8,805	394,657	122
1953-54	183,983	1,638	16,939	108	202,668	62
1954-55	239,760	39,951	29,970	5,600	315,281	98
1955-56	241,170	64,733	28,521	3,550	337,974	106
1956-57	126,302	107,103	50,289	3,009	286,703	111
1957-58	207,806	111,008	15,062	3,152	337,028	118
1958-59	257,597	80,607	19,601	1,771	359,576	122
1959-60	259,510	81,115	20,206	1,852	362,683	206

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Year	Whitefish	Walleye	Pike	Others	Total	No. of Licenses
1960-61	291,257	31,071	21,220		343,548	172
1961-62	192,045	48,029	12,539		252,613	94
1962-63	202,273	94,192	21,608		318,073	94
1963-64	140,146	74,685	28,644	35,407	278,882	81
1964-65	77,945	153,171	49,751	99,615	380,482	99
1965-66	137,088	87,208	40,437	99,615	364,348	98
1966-67	187,654	76,030	19,907	2,494	286,085	88
1967-68	234,509	62,469	11,609	3,161	311,748	110
1968-69	208,312	83,504	21,863	6,161	319,840	79
1969-70	201,105	86,313	32,817		320,235	90
1970-71	185,542	82,664	21,150		289,356	72
1971-72	237,215	72,536	12,010		321,761	68
1972-73	223,195	42,931	11,291	68,736	346,153	64
1973-74	232,671	31,388	9,700		273,759	60
1974-75	267,022	3,753	5,245	90,800	366,820	35
1975-76	288,068	20,669	6,533	37,001	352,271	34
1976-77	281,362	29,696	11,342	54,480	376,880	33
1977-78	171,460	59,277	18,414	4,790	253,941	31
1978-79	244,300	15,742	24,796	976	285,814	31
1979-80	223,072	1,584	40,334	4,767	269,757	31
1980-81	148,115	24,237	43,520	1,596	217,468	29
1981-82	187,819	261	7,159	810	196,056	27
1982-83	239,959	22,496	15,306	296	278,057	31
1983-84	237,019	17,148	14,759	1,085	270,011	31
1984-85	189,713	9,450	23,941	994	224,098	36
1985-86	75,516	3,348	20,064	4	98,932	26
1986-87	110,563	8,434	22,700	750	142,447	30

Appendix IV Summary of Angler catch records, Dore Lake, 1985.

Month	Location	Harvest (kg) Pike	Walleye	Total
May	South Bay Campground	0	0	0
	Michel Pt. Campground	499	0	499
	Tower Beach Campground	225	0	225
	Dore Lake Lodge	988	10	998
	Michel Lodge	972	6	978
	Total - May	2684	16	2700
June	South Bay Campground	0	0	0
	Michel Pt. Campground	270	0	270
	Tower Beach Campground	82	0	82
	Dore Lake Lodge	803	1	804
	Michel Lodge	736	1	737
	Total - June	1891	2	1893
July	South Bay Campground	0	0	0
	Michel Pt. Campground	875	0	875
	Tower Beach Campground	248	0	248
	Dore Lake Lodge	1190	10	1200
	Michel Lodge	313	1	314
	Total - July	2626	11	2637
August	South Bay Campground	-	-	-
	Michel Pt. Campground	210	0	210
	Tower Beach Campground	135	0	135
	Dore Lake Lodge	919	0	919
	Michel Lodge	-	-	-
	Total - August	1264	-	1264
Season Totals	South Bay Campground	0	0	0
	Michel Pt. Campground	1854	0	1854
	Tower Beach Campground	690	0	690
	Dore Lake Lodge	3900	21	3921
	Michel Lodge	2021	8	2029
	Total	8465	29	8494